FINAL REPORT

HUMAN HEALTH RISK ASSESSMENT - ASHLAND/NORTHERN STATES POWER LAKEFRONT SUPERFUND SITE

Prepared for

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September 26, 2007

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TABLE OF CONTENTS

TABLE OF CONTENTS

Tables

Figures

Attachments

Acronyms

ACGIH	American Conference of Governmental Industrial Hygienists
ALM	Adult Lead Model
ATSDR	Agency for Toxic Substances and Disease Registry
AWQC	Ambient Water Quality Criteria
bgs	below ground surface
CDC	Centers for Disease Control
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm/sec	centimeters per second
COPC	Chemical of Potential Concern
CR	Cancer Risk
Csat	Chemical-specific Saturation Limit
CSM	Conceptual Site Model
CTE	Central Tendency Evaluation
DQO	Data Quality Objectives
EPC	Exposure Point Concentration
ft/ft	foot per foot
HEAST	Health Effects Assessment Summary Tables
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
IR	Intake Rate
IRIS	Integrated Risk Information System
IEUBK	Integrated Exposure Uptake Biokinetic Model
m^3/day	cubic meters per day
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mg/m^3	milligrams per cubic meter
MGP	Manufactured Gas Plant
MSL	mean sea level
MVUE	Minimum Variance Unbiased Estimate
NAPL	Non-aqueous Phase Liquid
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NSPW	Northern States Power Wisconsin

ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
PAH	Polycyclic Aromatic Hydrocarbon
PEF	Particulate Emission Factor
ppm	parts per million
PPRTV	Provisional Peer-reviewed Toxicity Value
PRG	Preliminary Remediation Goal
QAPP	Quality Assurance Project Plan
RAGS	Risk Assessment Guidance for Superfund
RAIS	Risk Assessment Information System
RBC	Risk-based Concentration
RBSC	Risk-based Screening Concentration
RfC	Reference Concentration
RfD	Reference Dose
RI/FS	Remedial Investigation and Feasibility Study
RME	Reasonable Maximum Exposure
RV	Recreational Vehicle
SF	Slope Factor
SQL	Sample Quantitation Limit
TIC	Tentatively Identified Compound
UCL	Upper Confidence Limit
U.S.C.	United States Code
USEPA	United States Environmental Protection Agency
VF	Volatilization Factor
VI	Vapor Intrusion
VOC	Volatile Organic Compound
WDHFS	Wisconsin Department of Health and Family Services
WDNR	Wisconsin Department of Natural Resources
WQS	Water Quality Standard
WWTP	Wastewater Treatment Plant
µg/L	micrograms per liter
µg/dL	micrograms per deciliter

The results of the human health risk assessment (HHRA) for Ashland/NSP Lakefront Superfund Site (Site) in Ashland, Wisconsin (Site) indicate that seven exposure pathways result in estimated risks that exceed U.S. Environmental Protection Agency's (USEPA's) target risk levels and eight exposure pathways result in estimated risks that are either equivalent to or exceed the Wisconsin Department of Natural Resources (WDNR) threshold of an incremental cancer risk (CR) of one in one hundred thousands (1×10^{-5}). These exceedances are indicated below.

Exceeds USEPA Threshold ($CR \geq 1\times10^{-4}$ or HI >1)	**Exceeds WDNR Threshold ($CR \geq 1\times10^{-5}$ or HI >1)**
Residents (Soil[0-3 feet and all soil depths] - Cancer)	Residents (Soil[0-3 feet and all soil depths] - Cancer)
–	Residential Child (Soil – Noncancer)
Construction Worker (Soil [0-10 feet bgs]/Groundwater)	Construction Worker (Soil [0-10 feet bgs]/Groundwater)
Construction Worker (Trench Air)	Construction Worker (Trench Air)
Adult Swimmer (Surface Water)	Adult Swimmer (Surface Water)
Adult Wader (Surface Water/Oil slicks)	Adult Wader (Surface Water/oil Slicks/Sediment)
Industrial Worker (Indoor Air)	Industrial Worker (Indoor Air)
Subsistence Fisher (Biota)	Subsistence Fisher (Biota)

HI: Hazard index for noncarcinogenic effects

These include estimates for the reasonable maximum exposure (RME) scenarios for potential cancer risks and non-cancer risks. These conclusions are based on assumed exposures to soil in the filled ravine area (for residential receptors) and the filled ravine, upper bluff and Kreher Park area (for construction worker receptors), and to indoor air samples collected at the Site.

Carcinogenic risks based on central tendency evaluation (CTE) scenarios indicate that only the residential receptor exposure to soil (all soil depths to 10 feet bgs) are estimated to be at 1×10^{-4}, the upper-end of the USEPA target risk range or greater than the WDNR threshold. Carcinogenic risks based on the RME scenarios for residential receptor exposure to soils for all depths exceed the 1×10^{-4} the upper-end of the USEPA target risk range. Noncarcinogenic risks for the residential receptor (for soil depths 0-1 foot and 0-3 feet bgs) and risks associated with the construction scenario are within acceptable levels. However, residential receptor exposure to subsurface soil is not expected, given the current and potential future land use of the Site. For this Site, residential risks associated with CTE exposures to surface soil (0 to 1 foot bgs) are within the target risk ranges, but the RME exposures exceed the target risk range.

Although the results of the HHRA indicate risks for the construction workers under the RME conditions exceed USEPA's target risk levels, the assumptions used to estimate risks to this receptor were conservative and assumed the worst case. Given both the current and future land use of the Site, it is unlikely that construction workers would be exposed to soil in the filled ravine and Upper Bluff. The most likely scenario for the future construction worker is exposure to soil within 0 to 4 feet bgs in Kreher Park (a typical depth for the installation of underground utility corridors), as most activities associated with the implementation of the future land use would be associated with regrading, landscaping, and road or parking lot construction. However, the depth to groundwater in Kreher Park is relatively shallow due to the lake-filled material comprising most of the park. Consequently, it is possible that construction workers excavating and installing utilities in such underground corridors in certain portions of Kreher Park may encounter chemicals of potential concern (COPC) impacted sub-surface soils and non-aqueous phase liquids (NAPLs) in groundwater.

An HI of 3 was calculated for the general industrial worker exposure to indoor air pathway under the RME conditions. This risk level is likely to be an overestimate because:

- It was estimated using the maximum detected concentrations as the concentrations at points of exposure.
- It was calculated based on USEPA default exposure parameters for the industrial /commercial workers (i.e., an individual works at the Site for 8 hours per day, 5 days per week, 50 weeks per year for a total of 25 years). The NSPW Service Center is used as a warehouse; there is an office space inside the building, but used only on a part-time basis.

Cancer risks to subsistence fisher (finfish) are equivalent to 1×10^{-4}, the upper-end of the USEPA target risk range, and greater than the WDNR threshold of 1×10^{-5}. Noncarcinogenic risk is within acceptable limits for both USEPA and WDNR.

Risks to recreational children (surface soil) are equivalent to1×10^{-5}, which is the WDNR cancer risk threshold. However, risks to adolescent and adult receptors exposed to surface soil are below the USEPA acceptable risk range and below the WDNR risk threshold.

Risks to waders and swimmers (sediments), industrial workers (surface soil), and maintenance workers (surface soil) are all within USEPA's target risk range of 10^{-4} to 10^{-6} for lifetime cancer risk and a target HI of less than or equal to 1 for non-cancer risk and are greater than the WDNR threshold of 1×10^{-5} for lifetime cancer risk and a target HI of less than or equal to 1 for non-cancer risk.

At the request of the Wisconsin Department of Health and family Services (WDHFS), risks were also estimated for construction workers exposed to "oily materials" in groundwater via dermal contact and swimmers and waders who may be exposed to oil slicks in surface water via ingestion and dermal contact. Because no media-specific concentrations are available for either scenario, risks were estimated using analytical data collected from the product stream from the active free product recovery system for the Copper Falls aquifer or chemical-specific solubility values detected in the dense non-aqueous phase liquid (DNAPL) sample. Risks to construction workers exposed to "oily material" in groundwater and adult swimmers and waders exposed to "oil slicks" in surface water is greater than both the USEPA upper risk range (CR 1×10^{-4} and HI of 1) and than WDNR threshold (CR 1×10^{-5} and HI of 1). However, it is important to note that there is much uncertainty associated with estimating risks to oily material in groundwater or oil slicks in surface water. The primary uncertainties are associated with the lack of:

- Established methodology for estimating this exposure pathway
- Relevant oily material data resulting in the use of DNAPL data that are expected to result in an overestimate of risk.

Northern States Power Company, a Wisconsin corporation, d/b/a Xcel Energy (hereafter "NSPW"), submits this baseline Human Health Risk Assessment (HHRA) in accordance with the United States Environmental Protection Agency (USEPA) approved Remedial Investigation and Feasibility Study (RI/FS) Work Plan (URS, 2005), as amended (RI/FS Work Plan). This HHRA has been prepared to support the Ashland/NSP Lakefront Superfund Site (Site) RI/FS being conducted under the regulatory framework of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. 9601, et seq. and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR Part 300.

1.1 PURPOSE

The purpose of the baseline HHRA is to provide a risk-based interpretation of the data collected during the RI and to provide conservative estimates of potential human health risks posed by chemicals that are present at or migrating from the Site. The results of the HHRA may also be used as the basis for risk management decisions. In summary, the objectives of the baseline HHRA are to:

- Quantify exposures and characterize baseline risks to potentially exposed individuals (both current and future) at or near the Site;
- Identify those chemicals that may pose risks to human health; and
- Provide the basis for risk management decisions.

1.2 APPROACH

This HHRA was completed using the data collected as part of RI/FS along with historical data from work previously completed by the Wisconsin Department of Natural Resources (WDNR) and the Wisconsin Department of Health and Family Services (WDHFS). The methodology for completing the HHRA follows guidance presented in *Risk Assessment Guidance for Superfund (RAGS): Volume I. Part A – Human Health Evaluation Manual* (USEPA, 1989) and several more recent regulatory guidance documents and resources as appropriate such as:

- *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (OSWER 9355.4-24, March 2002)(USEPA, 2002a);
- *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, Part E, Supplemental Guidance for Dermal Risk Assessment* (EPA/540/R/99/005, OSWER 9285.7-02EP, PB99-963312, July 2004)(USEPA, 2004a);

- *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites* (OSWER 9285.6-10 December 2002)(USEPA, 2002b);
- *Exposure Factors Handbook* (EPA/600/P-95/002) August, 1997 (USEPA, 1997a); and
- A summary of up-to-date guidance and screening criteria presented in http://risk.lsd.ornl.gov/homepage/rap_docs.shtml, (Oak Ridge National Laboratory [ORNL], On-line).

A draft HHRA was submitted for review on April 7, 2006 as a stand alone report and on June 5, 2006 as part of the draft RI Report. The draft HHRA has been revised based on agency review comments provided on August 25, 2006 and October 27, 2006 and decisions agreed upon during the November 12, 2006 meeting between USEPA, WDNR, WDHFS and NSPW. By letter dated December 22, 2006, USEPA sent NSPW a notice of deficiency regarding the HHRA. USEPA provided a second notice of deficiency on July 10, 2007, giving NSPW 21 days to cure the deficiency by incorporating USEPA's modifications. NSPW submitted the revised HHRA on July 31st. USEPA, in consultation with WDNR and the WDHFS, reviewed NSPW's revised HHRA. In a letter dated August 23, 2007, USEPA agreed to incorporate most of NSPW's language changes, but contained other modifications. This document contains NSPW's language changes and addresses remaining issues outlined in USEPA's letter and attached document dated August 23, 2007. This HHRA incorporates the following components:

- Section 2 Data Evaluation
- Section 3 Exposure Assessment
- Section 4 Toxicity Assessment
- Section 5 Risk Characterization
- Section 6 Uncertainty Analysis

1.3 SITE DESCRIPTION

The Site is located in S 33, T 48 N, R 4W in Ashland County, Wisconsin, shown on **Figure 1**. The Site consists of property owned by NSPW, a portion of Kreher Park, and sediments in an offshore area adjacent to Kreher Park. Existing site features showing the boundary of the Site are shown on **Figure 2**. The Site includes the following:

- NSPW's property (a former manufactured gas plant [MGP]), and potentially the areas beneath residences located on the upper bluff,

- Private, non-industrial areas including 17 single-family homes, hotel, a school, a playground, and a church (also located on the upper bluff);
- Soils along the flat terrace adjacent to the Chequamegon Bay shoreline including Kreher Park (filled lakebed areas north of the bluff face);
- Other areas of the filled former lakebed not within the Kreher Park boundary including a former City Wastewater Treatment Plant (WWTP) and buildings, grassed areas, and boat storage; and
- Impacted sediment in the lake adjacent to the filled lakebed area north of Kreher Park.

On the upper bluff, the NSPW property includes a small office building and parking lot fronting on Lake Shore Drive, and a larger vehicle maintenance building and parking lot area located south of St. Claire Street between Prentice Avenue and 3rd Avenue East. The office building and vehicle maintenance building are separated by an alley. A gravel-covered parking and storage yard area, with a large microwave tower, is located north of St. Claire Street between 3rd Avenue East and Prentice Avenue. A filled ravine formerly opening to the north underlies this storage yard. The area occupied by the buildings and parking lots is relatively flat, at an elevation of approximately 640 feet above mean sea level (MSL). Surface water drainage from the NSPW property is to the north. Seven residences bound the Site north the NSPWs building. Our Lady of the Lake Church and School is located immediately west of NSPW's buildings, with nine private homes further west of the school. Private homes are located immediately east of Prentice Avenue. To the northwest of the upper bluff, the Site slopes abruptly to the Canadian National (formerly Wisconsin Central Limited) Railroad property that marks the former Lake Superior shoreline and then to the City of Ashland's Kreher Park, beyond which is Chequamegon Bay.

Based on current data, the impacted area of Kreher Park consists of a flat terrace overlaying fill material adjacent to the Chequamegon Bay shoreline. The surface elevation of the park varies approximately 10 feet, from 601 feet MSL, to about 610 feet MSL at the base of the bluff overlooking the park. The bluff rises to an elevation of about 640 feet MSL, which corresponds to the approximate elevation of the NSPW property. The lake elevation generally fluctuates about two feet, from 601 to 603 feet MSL, however, in 2007 lake levels were notably lower. At the present time, the park area is predominantly grass covered. A gravel overflow parking area for the marina occupies the west end of the Kreher Park property, while a miniature golf facility formerly occupied the east end of the Site. The former City of Ashland WWTP and associated structures front the bay inlet on the north side of the Kreher Park property. The impacted area of Kreher Park (excluding the affected sediments area) occupies approximately 13 acres and is bounded by Prentice Avenue and a jetty extension of Prentice Avenue to the east, the Canadian National railroad to the south, the Ellis Avenue and the marina extension of Ellis Avenue to the west and Chequamegon Bay to the north.

The offshore area with approximately 10 acres of impacted sediments is located in an inlet created by the Prentice Avenue jetty and marina extensions previously described. For the most part, impacted sediments are confined in the inlet bounded by the northern edge of the line between the Prentice Avenue jetty and the marina extension. Data collected to date indicate that impacted sediment levels sharply decline beyond this boundary. The affected sediments consist of lake bottom sand and silts, and are overlain by a layer of wood chips and larger wood waste fragments (slab wood, logs), likely originating from former lumbering operations. The wood waste layer varies in thickness from zero to seven feet, with an average thickness of nine inches. Based on current data, the entire area of impacted sediments encompasses approximately ten acres.

1.3.1 Population and Land Use

The Site is located in Ashland County, Wisconsin. Ashland County has a population of 16,866 and covers a land area of 1,047 square miles. The City of Ashland (population 8,620 based on the 2000 Census) is the largest city in Ashland County, as well as the county seat. The Bad River Indian Reservation, an area of 200 square miles, is located entirely within Ashland County and has a population of 1,538.

According to census estimates, the population of Ashland County and the City of Ashland has changed little since 1990. Ashland County grew by 3.3% between 1990 and 1999 (16,307 to 16,866). The City of Ashland dropped in population by 0.8% (8,695 to 8,620). This is consistent with the limited population growth in the region over the last 20 years.

Residents are served by the city's municipal water supply, which is provided from Chequamegon Bay surface water. The surface water intake is located at Longitude 90º 50' 29" E and Latitude 46º 36' 25"N. The intake is located in approximately 23 feet of water and is approximately one mile northeast of the Site, and not affected by site-related contamination. The area is located in the Lake Superior Lowland Physiographic Province characterized by flat to undulating topography underlain by red glacial clay (Miller Creek Formation). Uplands lie to the south of Ashland and are characterized by rolling hilly topography and underlain by sand and gravel soils (Copper Falls Formation). Elevations in the Ashland area range from 601 feet MSL datum (Lake

Superior surface elevation) to approximately 700 feet MSL. Regional slope is generally to the north.

1.3.2 Geological and Hydrogeological Setting

The filled ravine at the upper bluff is a former drainage feature that begins near the NSPW administration building fronting on Lakeshore Drive, and deepens and widens to the north **(Figure 3)**. The mouth of the ravine opens to Kreher Park through the bluff face at the north end of the gravel storage yard. The maximum depth of fill in the ravine at the mouth is approximately 33 feet.

The Copper Falls Aquifer is a confined, variably coarse to fine-grained sand (reworked glacial till) that underlies the entire Lakefront site **(Figure 4)**. The formation is overlain by the surficial Miller Creek Formation, which is a lacustrine clay to silt till unit. At the NSPW property, the Miller Creek Formation has a maximum thickness of about 35 feet; the thinnest portion of the unit is at the mouth of the former ravine, at approximately four feet.

Surficial soils at the Site are underlain by a variety of fill materials, including wood waste (slabs and sawdust), solid waste (including concrete, bricks, bottles, steel, wire, and cinders), and earthen fill (including a buried clay berm along the shoreline on the northeast side of the Site near the former WWTP). The fill materials at Kreher Park are underlain by a variably 0 to 5.5 foot thick layer of beach sand separating the fill from the underlying Miller Creek Formation. The Miller Creek soils encountered at the Site consist of clays and silts and range in thickness from 7 to 40 feet (the Miller Creek Formation thickens from the bluff face toward the shoreline and beyond to the north). Silty sand and gravel soils of the Copper Falls Formation are present beneath the Miller Creek soils. Thickness of the Copper Falls Formation at the site has not been determined, though monitoring wells installed in December 2003 suggest that the bedrock is at least 190 feet below ground level in at least some locations. The Copper Falls Formation consists of granular, cohesionless material deposited by glacial melt waters. Bedrock was encountered at 192 feet during the latest exploration drilling program at the NSPW property during December 2003 (monitoring well MW-2C). Bedrock in the Ashland area consists of Precambrian sandstones. To the south, beneath the NSPW facility, the Copper Falls consists of silty sands with discontinuous lenses of silty clay and silt. To the north, beneath Kreher Park, the Copper Falls formation consists of outwash sediments (i.e., clean sands with occasional gravel intervals).

Geology of the upper bluff area in the vicinity of the former ravine consists of earthen fill materials, with clay soils of the Miller Creek Formation on the flanks of the former ravine. The ravine fill unit consists of silty clay fill material mixed with ash, cinders, slag, and fragments of bricks, concrete, glass, wood, and other solid waste. The thickness of the fill diminishes to less than three feet beyond the flanks of the ravine to the east and west. Miller Creek clay soils are present at the base of the former ravine; however, the thickness of these soils has been measured at as little as four feet at one soil boring location (at the mouth of the ravine where it opened to the former lake shoreline). Sand and gravel layers interbedded with silty clay lenses have been encountered near the contact of the Miller Creek Formation and the underlying Copper Falls aquifer.

Offshore geology consists of a discontinuous layer of submerged wood chips on the lake bottom underlain by variably fine to medium grained sediments. The sediments are underlain by silts and clays of the Miller Creek Formation. The Copper Falls Formation was not encountered during earlier investigations of the offshore sediments. Consequently, the thickness of the Miller Creek Formation below the bay is unknown.

The water table is found within the fills overlying the Miller Creek Formation at the Site. (Where the Miller Creek is the surficial soil unit, the water table is also present within the Miller Creek Formation.) The hydraulic conductivity of the shallow soils and fill materials ranges from approximately 0.1 to 5×10^{-5} centimeters per second [cm/sec] (URS, 2005). The higher hydraulic conductivity values are typically found in locations with saturated wood waste fill. The horizontal hydraulic gradient is very flat (< 0.0004 foot per foot [ft/ft] to the north measured during June 2004) due to the high hydraulic conductivities on the Site.

Hydrogeology of the upper bluff area (the former MGP plant location of the Site) includes low permeability conditions (3×10^{-6} to 4×10^{-8} cm/sec) in the Miller Creek Formation comprising most of the shallow saturated soil in the area. Fill soils located in the former ravine area exhibit hydraulic conductivities approximately 1,000 times higher than the surrounding Miller Creek soils. The horizontal hydraulic gradient in the fill soils of the former ravine is approximately 0.09 ft/ft. Direction of the groundwater flow in the ravine fill is to the north (toward the mouth of the former ravine). An intermittent groundwater discharge to the surface used to be present at the base of the bluff in the proximity of the mouth of the former ravine in the form of a seep. This seep was found to be caused by a buried 12-inch clay tile pipe that traversed the length of the ravine at its base. The elevation of the seep was over five feet above the water table levels

measured in MW-7, formerly located immediately adjacent to the seep. The buried pipe was located and the seep area capped as part of the 2002 interim action response (URS, 2002).
Artesian conditions are present at the Kreher Park areas of the Site in the Copper Falls aquifer. Hydraulic head levels of approximately 17 feet above ground surface have historically been measured in an artesian well located at Kreher Park. However, artesian conditions have not been identified in the Copper Falls aquifer in the vicinity of the former ravine area or the upper bluff area. An upward hydraulic gradient is present in the Copper Falls aquifer in the northern portion of the upper bluff area, and diminishes and eventually changes to a downward gradient south of the alley separating the NSPW Service Center Building from the Administration Building parking area. The general direction of flow in the Copper Falls aquifer is to the north (toward Chequamegon Bay). Hydraulic conductivity values for the Copper Falls aquifer ranging from 5.9×10^{-4} cm/sec to 9.6×10^{-4} cm/sec were derived from a 48-hour aquifer performance test at the NSPW property in 1997. These data were used to later design an interim coal tar removal system installed by NSPW during 2000 (URS, 2005).

1.3.3 Surface Water Features

The Site is located on the shore of Chequamegon Bay. Regional surface water drainage flows to the north through Fish Creek and several small unnamed creeks and swales into Chequamegon Bay. Surface water at the Site flows either to the City of Ashland storm sewer system, or discharges directly to Chequamegon Bay. An open sewer is depicted on historic Sanborn Fire Insurance maps dating from 1901 to 1951 on the western portion of the Kreher Park area. The head of the sewer is shown at a location about two-thirds of the distance from the shoreline to the bluff face with no identified upstream inlet. It is not clear whether the open sewer was used for discharging storm water, sanitary wastewater or both to Chequamegon Bay.

Surface water sampling was conducted by Short Elliot Hendrickson Inc. (SEH) in 1998. No chemicals were detected above ambient water quality criteria (AWQC) in twelve unfiltered surface water samples collected on January 14 and 15, 1998. However, in one unfiltered water column sample collected during a period on May 14, 1998, when wave heights were estimated to be between 60 and 90 cm[1], benzo(a)anthracene and benzo(a)pyrene exceeded secondary chronic and acute water quality criteria values, respectively. No VOCs exceeded AWQC in that sample. It is unknown whether the contaminants in this sample were adsorbed onto suspended particulates or in a dissolved state.

The WDNR received a report from a citizen on November 15, 2005 that high winds at the time likely caused several oil slicks to form in the affected area of the bay inlet. USEPA subsequently forwarded several photos taken of these slicks to NSPW. This event corresponded to the high energy surface water sampling. In follow-up, NSPW's sampling crew inspected the area and did not observe any slicks. Additionally, Coleman Engineering personnel inspected the area from the shoreline and also reported no slick observations. The occasional formation of slicks or intermittent releases may occur during high energy events stronger than conditions observed during the November sampling event.

The high-energy samples were collected on November 14 and 15, 2005 during a period where wave conditions exceeded 30 centimeters during the 24-hour period prior to sampling. This investigation was conducted in accordance with the approved RI Work Plan. Details are provided in Appendix D to the BERA. For the majority of samples (both low energy and high energy), no contaminants were detected, including those collected during the high energy sampling event. VOCs including benzene, ethylbenzene, toluene and xylenes, along with a few PAHs were detected at very low levels in a few samples. Most of these detections were reported as estimated values because the chemicals were detected between the method detection limit (MDL) and limit of quantitation. Only one ecological sample and one human health sample yielded quantifiable values of benzene (ERA 07 1105-NB-FIL at 0.53 µg/L, and HHRA3-1105-UNF at 0.74 µg/L).

All reported detections for PAHs were estimated concentrations; the highest estimated concentration for naphthalene was 2 µg/L. No reported concentrations exceeded U.S. EPA Region V ecological screening levels (ESLs) or comparable screening criteria Sample results are included in the Surface Water Investigation report included in Appendix D of the BERA.

The polycyclic aromatic hydrocarbon (PAH) and volatile organic compound (VOC) impacted sediment is concentrated at the wood debris/sediment-water interface and concentrations generally decrease with depth, although exceptions are found in a few locations. The presence of impacted sediment and non-aqueous phase liquids (NAPLs) across the surface of the lakebed is consistent with the physical-chemical characteristics of the Site-related chemicals. The mode of chemical transport to sediments was likely through backfilling (i.e., construction activities associated with the former WWTP), historic surface water runoff, or possible discharge from one or more source areas (e.g., MGP plant, coal tar dump at Kreher Park, etc.).

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[1] It is likely this estimate was based upon crest to trough height rather than wave height compared to lake surface.

Information provided by the City of Ashland's Department of Public Works indicates that the City had a combined storm and sanitary sewerage system until the early to mid-1980s. The storm sewer system was separated from the sanitary system at that time to reduce flow to the former WWTP. In the past, storm water discharged directly to Chequamegon Bay through three known outfalls within the Site. Those outfalls have been closed and storm water is now re-routed to a discharge point east of the Site.

1.3.4 Groundwater Use

Groundwater is present in both a shallow aquifer and a confined deep aquifer. Currently the shallow groundwater is not used as a potable water source. There are two artesian wells in the Site vicinity—one located near Prentice Avenue on the eastern boundary of the Site and the other located near the marina on the western boundary. Both wells draw water from the Copper Falls aquifer, which is a deep aquifer separated from the shallow groundwater by the Miller Creek Formation (URS, 2005; ATSDR, 2003). The City of Ashland temporarily closed these wells for public use in August 2004. The City of Ashland will determine when the wells will be reopened pending the outcome of the RI/FS and subsequent cleanup actions. To date water from these wells have met all federal and state safe drinking water standards. Water from these artesian wells is considered safe to drink as Site-related chemicals have not been detected in these wells at levels of concern (ATSDR, 2003).

Except for the two artesian wells at Kreher Park, the Copper Falls aquifer is not used for drinking water and is not considered a source of human exposure. Shallow groundwater at the Site is not a drinking water source for the City of Ashland. Drinking water at the Site is provided by the City of Ashland that draws its water from intakes in Lake Superior, located approximately one mile northeast of the Site, which is outside the known extent of Site-related sediments and surface water impacts. Therefore, there are no known current receptors to shallow groundwater beneath the Site. However, workers at the former WWTP had reported previous direct contact with tar-like product floating on shallow groundwater when they were in trenches where pipes transferred sewage to the plant (ATSDR 2003). Such activities are currently not occurring, but could occur to the future workers when performing construction activities below the water table at Kreher Park.

1.3.5 Current and Potential Future Land Use Patterns

The upland area (upper bluff/ravine area) is primarily used for industrial or commercial purposes.[2] Portions of the Site (e.g., the abandoned WWTP) are subject to trespassing activities. These areas, some of which are public streets, are readily accessible to the public although they are generally covered by clean fill or roadways.

The area near the lakefront is zoned conservancy district; i.e., acceptable for use as parkland. The filled lakebed portions of the Site are comprised of City parkland (Kreher Park). The area is readily accessible by the public and a majority of the Kreher Park area of the Site is mowed and maintained for public use. No physical barrier exists at the shoreline to prevent swimming or wading in the bay where the impacted sediments have been found, although warning signs are posted along the shore of the affected area. Kreher Park and the impacted sediments are surrounded by facilities that draw the public to the lakefront—a city marina, public swimming beach, a boat ramp and a recreational vehicle (RV) park and campground. Warning buoys also prohibit boats into the affected area.

According to the *Ashland Wisconsin Waterfront Development Plan*, prepared by SmithGroup JJR for the City of Ashland, Wisconsin in March 2002, the swimming beach will be retained but the existing RV park, located immediately adjacent to the Ashland property to the east, will be relocated to the Clarkson Dock farther to the east. The plan proposes that the existing RV park land will be redeveloped into a parking lot and an interpretive center for the ore freighter and/or the Great Lakes Shipping and Mining Museum. The future reuse plan for the Site has not been determined pending remedies to be implemented at the lakefront.

[2] Although neighboring residences and the Our Lady of the Lake school and parish grounds are designated within the Site boundary, these areas have been characterized as affected by contaminated groundwater only.

One of the first steps of the baseline HHRA process was to review data collected during site investigations to develop a data set to support the site-specific HHRA. The analytical data from the Site were reviewed to:

- Validate and organize sampling data that were of acceptable quality for their use in the detailed HHRA; and
- Identify a set of chemicals that are Site-related.

Data evaluation was conducted as follows.

2.1 DATA REVIEW PROTOCOL

RI analytical and field data were first compiled. Validated data were entered into the USEPA-specified database and tabulated for use. The data from previous sampling efforts and this RI were reviewed to:

- Identify the nature and extent of Site-related chemical; and
- Evaluate the usability, including any uncertainties associated with the data.

The data were checked against the data quality objectives (DQOs) identified in the approved Quality Assurance Project Plan (QAPP) (URS, 2005). Details of the procedures for assessing the precision, accuracy, representativeness, completeness and comparability of field data and analytical laboratory data are described in the QAPP. Qualifications to the data usability are discussed in the quality assurance section of any reports presenting the data. Data generated under this program were considered technically sound and of sufficient quality and quantity to support the needs of the data users.

Methods used to develop a data set to support the development of the HHRA are described in the following sections.

2.1.1 Tentatively Identified Compounds

Both the identity and reported concentrations of tentatively identified compounds (TICs) are highly uncertain. As outlined in the approved RI/FS Work Plan (URS, 2005), TICs were excluded from further evaluation in the baseline HHRA.

2.1.2 Qualified Data

Qualifiers pertaining to uncertainty in the identity or the reported concentration of an analyte were assigned to certain analytical data by the laboratories or by persons performing data validation. The following qualifiers were used for HHRA data.

QUALIFIER	DEFINITION	USE OF QUALIFIED DATA IN HHRA
U	The analyte was analyzed for, but was not detected above the reported sample quantitation limit (SQL).	If the analyte is selected as a chemical of potential concern (COPC), then it is assumed to be present at one-half the SQL.
J	The analyte was positively identified; however, the associated numerical value is an estimate of the concentration of the analyte in the sample.	If the analyte is selected as a COPC, it is assumed to be present at the estimated concentration.
UJ	The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is an estimate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.	If the analyte is selected as a COPC, then it is assumed to be present at one-half the SQL.
R	The sample results are rejected and are, therefore, unusable due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.	Data were excluded from the HHRA.

2.1.3 Duplicate Results

The highest measured concentrations of duplicate sample analytical results were used as the concentration term in the HHRA. If both duplicate samples are non-detect, then one-half of the lower reporting limit was adopted as the proxy sample point concentration for the purpose of calculating exposure point concentrations (EPCs).

2.1.4 Data Tabulation

To facilitate the data evaluation process, the analytical results were tabulated as follows:

- The analytical data were divided into groups by sample location identification numbers, sample collection dates, sampling zone, sampling areas, and environmental media of concern.
- Analytical results were reported in the text, tables and figures using a consistent and conventional unit of measurement such as microgram per liter (µg/L) for groundwater and surface water analyses, milligrams per kilogram (mg/kg) for soil and sediment analyses, and milligrams per cubic meter (mg/m^3) for air analyses.

Summary tables were prepared in accordance with the format recommended in RAGS, Part D (USEPA 2001a), to present relevant statistical data, such as the frequency of detection, the detection limits, the range of detected concentrations, the distribution of data and the source term concentrations to be used in the HHRA. However, RAGS Part D formatted tables provided by USEPA were not used to present this information.

2.2 ANALYTICAL DATA USED TO EVALUATE RISK

Although there has been a considerable amount of data collected at the Site, not all data collected were considered appropriate for evaluating human health risk. The sections below summarize the data selected for this HHRA.

2.2.1 Soil

Both surface and subsurface soil from several historical sampling events were evaluated in this HHRA. Data from sampling events completed between 1994 and 2005 were evaluated for inclusion in the HHRA. In general, all data from the previous investigations were used in the HHRA. However, a separate evaluation was performed by excluding chemical concentrations exceeding the soil saturation limit (Csat) in the derivation of concentration terms. This evaluation was prepared in response to review comments on the draft HHRA report. Information regarding this evaluation is presented in **Attachment H**.

Attachment H1 Calculation of Chemical-specific Csat Values
Attachment H2 Exposure Point Concentration Summary

Attachment H3 ProUCL Output Tables
Attachment H4 Risk Calculations

Surface soil is defined as soil from 0 to 1 foot below ground surface (bgs). Subsurface soil is defined as soil between 1 and 10 feet bgs. For this Site, 10 feet was selected as the limit to which construction activities may occur. Ten feet was selected based on the future recreational land use of the Site. It was assumed that 10 feet was the maximum depth at which utilities would be installed.

Tables 1 to **5** present the surface and subsurface soil sample locations used for this evaluation by receptor. These tables also define the source of each data point used in the evaluation. **Table 2-6** of the RI report identifies the analytical parameters completed for soil. **Tables 4-8A** and **4-8B** of the RI report provides a summary of the analytical results for surface and subsurface soil. **Figure 5** graphically presents the sample locations selected to evaluate human receptors at the Site.

2.2.2 Sediment

The sediment data used to evaluate human receptors was selected based on those areas in Chequamegon Bay that are associated with human activity and are at depths that are likely to be contacted. Waders are typically assumed to come in contact with surface sediments only when evaluating exposures associated with a wading scenario. For this HHRA, sediment data between 0 to 2 foot in depth and with 4 feet or less of surface water cover were used in response to review comments on the draft HHRA Report.

Presented below is a list of sediment locations evaluated in the HHRA.

2200N-1600E	2400N-2000E
2250N-1400E	2400N-2100E
2300N-1600E	2400N-2100E
2300N-1700E	2400N-2200E
2350N-1400E	2400N-2300E
2400N-1200E	2500N-2300E
2400N-1300E	2600N-2400E

These data were selected based on a conservative assumption that waders may come in contact with affected sediments at depths of up to 4 feet when collecting wood. In addition, the sampling locations selected to evaluate risk were also chosen to reflect the estimated 2 feet drop in Lake Superior water levels observed in 2007.

In addition, it was also assumed that sediment exposures could occur during surface water exposures. In this instance chemicals that are adsorbed on suspended sediment particles are assumed to be available for contact. However, there are no measured concentrations for this data set. Instead, a contact rate was developed based on the total suspended solids measurement of surface water using the equation below.

$$\text{Sediment Ingestion Rate } {}^{mg}\!/_{hour} = \text{Surface Water Ingestion Rate } \left({}^{mL}\!/_{hour}\right) \times \textit{Total}\text{ Solids } {}^{mg}\!/_{mL}$$

Table 6 presents the sediment data used for this HHRA. **Table 2-6** of the RI report identifies the analytical parameters completed for sediment. **Table 4-9** of the RI report provides a summary of the analytical results for sediment. **Figure 5** outlines those locations that were selected to evaluate human receptors at the Site.

2.2.3 Surface Water

It was assumed that all surface water within affected areas of Chequamegon Bay could be accessed during recreational activities; therefore, analytical data collected in 1998 (by SEH) and 2005 (as part of the RI) were used in the HHRA.

Evaluating exposures to contaminated surface water has been challenging at the site due to a limited number of samples collected when natural factors caused the release of tar slicks. On November 15, 2005, during RI sampling activities, surface water samples were collected shortly after a tar slick was reported and photographed by a citizen, however, no slicks were observed by sample collectors and the subsequent data does not indicate notable surface water impacts. However, based on a single surface water sample collected on January 14 and 15, 1998, the 1998 SEH report calculated unacceptable levels of current and future health risks for workers, trespassers, and people engaged in recreational activities on the site. Since this exposure pathway poses one of the greatest potential health risks at the site, the revised HHRA report includes an evaluation of exposures to “oil slicks” in surface water. Because no samples of the “oil slick” have been collected, this exposure medium and associated pathways were evaluated using:

- Laboratory analytical data of the dense non-aqueous phase liquid (DNAPL) samples collected from the product stream recovered from the active free product recovery system for the Copper Falls aquifer (**Attachment I1**)

- Chemical-specific solubility values of chemicals detected in the DNAPL sample (**Attachment I2**).

The use of this alternative data in evaluating the surface water exposure pathway has limitations and uncertainties, and is very conservative. A discussion of these limitations and uncertainties associated with the use of this data is provided in **Section 6**.

Table 7 identifies those sample data by sampling event that were used to evaluate exposure to surface water. **Table 2-6** of the RI report identifies the analytical parameters completed for surface water. **Table 4-11** of the RI report provides a summary of the analytical results for surface water. **Figure 5** shows those surface water locations that were selected to evaluate human receptors at the Site.

2.2.4 Air

2.2.4.1 Soil Vapor

Soil vapor samples were collected from soil vapor probes installed in the uppermost water-bearing unit in the vicinity of the former MGP facility. These samples were collected to provide data that were used to evaluate potential vapor migration and to ensure that soil vapors are not migrating off-site through subsurface soil towards adjacent private properties and into residential structures.

Table 8 presents the soil vapor data used for the HHRA. **Table 2-7** of the RI report identifies the analytical parameters completed for soil vapor. **Table 4-12** of the RI report provides a summary of the analytical results for soil vapor. **Figure 5** presents locations selected to evaluate human receptors at the Site.

2.2.4.2 Indoor Air Vapor Investigation

An indoor air sample was collected to evaluate the potential for vapor migration into the existing NSPW Service Center building, which overlies impacted soil in the backfilled ravine. The indoor air investigation was designed to evaluate the chemicals present in indoor air and sub-slab soil vapors to determine if this area is being impacted by soil vapor migration and intrusion.
Table 8 presents the indoor air data used for the HHRA. **Table 2-7** of the RI report identifies the analytical parameters completed for indoor air. **Figure 5** presents those locations selected to evaluate human receptors at the Site.

2.2.4.3 Trench Air

Construction worker exposures to VOCs in trench air were estimated using the maximum detected concentrations in groundwater for Kreher Park, the Upper Bluff, and the Filled Ravine areas of the Site.

Table 4-7 of the 2006 RI report presents the groundwater data used for the HHRA. **Figure 2-1** of the same report shows the locations where groundwater samples were collected.

2.2.5 Biota

Several species of fin fish were collected at the Site. However, for the HHRA only the following three were assumed to be consumed on a consistent basis. These fin fish include:

- Shorthead Redhorse (*Moxostoma macrolepidotum*)
- Walleye (*Stizostedion vitreum*)
- Rainbow Smelt (*Osmerus mordax*)

Although samples were prepared and analyzed as either whole fish or fillets, only data associated with the edible portion were used in the HHRA. It was assumed that the sample as prepared for sampling corresponded to the edible portion of the fish. Fish were prepared as indicated below.

- Eight whole fish composite samples of smelt were collected from the Site and prepared as if for frying, i.e. their heads and entrails removed.
- Walleye were filleted (the skin was removed)

- Shorthead redhorse were processed as for smoking or pickling, i.e., only the head and entrails were removed.

Table 9 lists the fish samples used for this HHRA. **Table 2-6** of the RI report identifies the analytical parameters completed for fish tissue. **Figure 6** illustrates the locations selected to evaluate human receptors at the Site.

2.2.6 Exposure to Shallow Uncovered Groundwater

While groundwater at the site is not currently used for drinking water, it is plausible that future construction workers digging trenches in Kreher Park could be exposed to COPCs in shallow groundwater via dermal contact, inhalation, and incidental ingestion. Because oily materials in groundwater at Kreher Park were not sampled during the RI, the COPCs and related concentrations used for evaluating this exposure pathway were derived from the laboratory analytical data of the DNAPL samples collected from the product stream recovered from the active free product recovery system for the Copper Falls aquifer (Appendix D6 of the RI report) and chemical-specific solubility values of chemicals detected in the DNAPL sample.

2.3 IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN

The procedures used for selecting COPCs evaluated in the baseline HHRA are summarized in the following sections.

2.3.1 Comparison with Background Concentrations

USEPA provides guidance indicating that an inorganic chemical can be excluded from further consideration in the HHRA if the detected concentrations are within the range of naturally occurring background levels (USEPA, 1989). Although background levels were identified in the RI/FS Work Plan as one of the screening criteria for identifying COPCs, no inorganic chemicals were excluded from the HHRA based on background comparison due to the lack of relevant medium-specific background levels.

2.3.2 Risk-Based Screening Approach

Although the presence of many chemicals may be identified in the environmental samples collected during site investigative activities, the results of a baseline HHRA are typically driven by a few chemicals and exposure pathways. To streamline the HHRA process and focus efforts on important issues, several methods have been developed by the regulatory agencies and the scientific community for the identification of chemicals and pathways that contribute significantly to the total risks posed by a site. A tiered, risk-based approach was used for the selection of COPCs to be further evaluated in the detailed HHRA for the Site. This approach is based on USEPA-developed methodology and follows standard HHRA procedures.

The maximum detected concentration of a chemical was compared with chemical- and medium-specific risk-based screening concentrations (RBSCs), defined as concentrations that are not expected to result in any adverse impact based on exposure conditions which served as the basis for the calculation. A chemical was selected as a COPC if its maximum detected concentration value exceeds the RBSC.

However, because there were no data collected that is representative of the oily materials in groundwater and surface water, laboratory analytical data collected from the product stream recovered from the active free product recovery system for the Copper Falls aquifer (Attachments I1 and I2) were used to evaluate risks to the construction worker, recreational swimmer and recreational wader receptors. Because there are no readily available risk-based screening values for oily materials, all chemicals that were detected in the product stream were selected as COPCs.

For the evaluation of construction worker dermal and inhalation exposures to VOCs in trench, the maximum detected groundwater concentration at three domains (Kreher Park, Upper Bluff, Filled Ravine) was used to estimate risk. All chemicals detected in groundwater were identified as COPCs. The groundwater data was not screened against RBSCs concentration prior to risk characterization. This approach potentially overestimates risks to construction worker receptors as not all chemicals detected were present at concentrations greater than their RBSC.

For purposes of this project, the preliminary remediation goals (PRGs) derived by the USEPA Region 9 (USEPA, 2004b) were adopted as the primary source of RBSCs because they are based on conservative assumptions of exposure scenarios. In addition, the use of these PRGs for screening purposes is considered to be common practice by USEPA Region 5.

For those chemicals lacking an RBSC (i.e., PRG or risk-based concentration [RBC]) the standard practice of selecting surrogate chemicals based on similarities in structure was used to determine if a chemical should be included as a COPC. The surrogates used are identified in **Tables 10** to **18.**

It should also be noted that RBSCs that are protective of noncarcinogenic effects were adjusted by a factor of 0.1 (i.e., divided by a factor of 10) to account for possible additive effects of multiple chemicals. All RBSCs for the protection of carcinogenic effects are based on a target cancer risk of 1E-06.

Sources of the RBSCs used for this project are presented below by media of concern.

	PRG				RBC	AWQC	VI
	Industrial Soil	**Residential Soil**	**Tap Water**	**Ambient Air**	**Fish Tissue**	**Surface Water Ingestion**	**Target Indoor Air Concentration**
Chemicals in Soil	×	×					
Chemicals in Indoor Air/Soil Gas							×
Chemicals in Trench Air				x			
Chemicals in Surface Water						×	
Chemicals in Sediment		×					
Chemicals in Fish Tissue					×		
Chemicals in Groundwater			x				

PRG – USEPA Region 9 Preliminary Remediation Goal (October 2004) (USEPA, 2004b).
RBC – USEPA Region 3 Risk-based Concentrations (October 2005) (USEPA, 2005a)
AWQC – USEPA National Recommended Water Quality Criteria (20026) for human health (water and organism) (USEPA, 2006a).
VI – Evaluating The Vapor Intrusion To Indoor Air Pathway From Groundwater and Soils (USEPA 2001b).

2.3.3 COPC Summary

The COPCs identified for this are primarily metals, SVOCs, and limited VOCs. A summary of the COPCs by receptor and medium is presented below. **Tables 10 to 19** present the detail screening summary tables by receptor and medium.

Summary of the COPCs by Receptor and Medium

Chemical[a]	Residential				Commercial/Industrial			Construction Worker	Recreational			
					General Industrial Worker		Maintenance Worker		Recreational User	Swimmer Wader		Fisherman
	SS & SB	SS	S:0-3	IA	SS	IA	SS	SS & SB & OA & GW	SS	SD	SW	Fish
Inorganics												
Antimony												
Arsenic	×	×	×		×		×	×	×			
Cadmium									×			
Iron										×		
Lead	×	×	×				×	×	×			
Manganese										×		
Thallium	×								×			
Vanadium										×		
SVOCs												
1-Methylnaphthalene	×		×					×		×		×
2-Methylnaphthalene	×							×		×		
Acenaphthene	×							×		×		
Benzo(a)anthracene	×		×				×	×	×	×	×	×
Benzo(a)pyrene	×	×	×		×		×	×	×	×	×	×
Benzo(e)pyrene												×
Benzo(b)fluoranthene	×		×				×	×	×	×	×	×
Benzo(k)fluoranthene	×		×					×	×	×	×	
Chrysene	×							×		×	×	
Dibenzo(a,h)anthracene	×		×					×		×	×	×
Dibenzofuran	×							×				×
Fluoranthene	×		×					×		×		
Fluorene	×							×		×		
Indeno(1,2,3-cd)pyrene	×		×				×	×	×	×	×	
Naphthalene	×		×					×		×		
Phenanthrene	×											
Pyrene	×		×					×		×		

Chemical[a]	Residential				Commercial/Industrial			Construction Worker	Recreational			
					General Industrial Worker		Maintenance Worker		Recreational User	Swimmer Wader		Fisherman
	SS & SB	SS	S:0-3	IA	SS	IA	SS	SS & SB & OA & GW	SS	SD	SW	Fish
VOCs												
1,2,4-Trichlorobenzene	×							×				
1,2,4-Trimethylbenzene	×		×			×		×				
1,3,5-Trimethylbenzene	×		×					×				
1,4-Dichlorobenzene						×						
Benzene	×		×			×		×				
Ethylbenzene								×				
n-Butyl benzene								×				
sec-Butyl benzene								×				
Carbon tetrachloride						×						
Methylene chloride										×		
Toluene								×				
Trichloroethylene						×						
Xylenes (total)	×							×		×		

Notes:
SS – surface soil
SB – subsurface soil
S:0-3 – soil (0 to 3 foot depth)
GW – shallow groundwater
IA – indoor air
OA – outdoor air
SD – sediment
SW – surface water

Exposure assessment involves the identification of the potential human exposure pathways at the Site for present and potential future use scenarios. Present conditions are as they exist today and future conditions are based on potential future land uses of the Site should there be no cleanup. Potential release and transport mechanisms were identified for contaminated source media. Exposure pathways identified in the WDNR HHRA (SEH, 1998) were finalized by assessing additional information gathered during this RI.

The exposure pathway links the sources, types of environmental releases, and environmental fate with receptor locations and activity patterns. Generally, an exposure pathway is considered complete if it consists of the following four elements:

- A source and mechanism of release;
- A transport medium;
- An exposure point (i.e., point of potential contact with an impacted medium); and
- An exposure route (e.g., ingestion) at the exposure point.

All present and potential future use scenarios presented in the RI/FS Work Plan (URS, 2005) were evaluated. However, additional site-specific information gathered during the implementation of the work plan resulted in the deletion of some exposure scenarios for quantitative analysis. The rationale for exclusion of these exposure scenarios is discussed in Section 3.1.4.

3.1 HUMAN HEALTH CONCEPTUAL SITE MODEL

A conceptual site model (CSM) for the Site has been developed to identify the focus of the HHRA. A schematic presentation of the CSM is included as **Figure 7**. The CSM integrates historical information to preliminarily define source areas, release and transport processes, points of contact with affected media, complete and incomplete exposure routes, and potentially exposed populations for current and expected future Site uses. The CSM was refined based on Site-specific information gathered during the implementation of the work plan.

3.1.1 Known and Suspected Sources of Chemical Impacts and Release Mechanisms

Based on information with respect to the history of the Site and the results of previous investigations, the potential primary sources of impact are likely associated with past industrial operations; e.g., past releases from the former MGP, releases of petroleum-based products from railcar off loading, releases from the construction and operation of the former WWTP, releases from filling activities at the Lakefront, or a combination of these possible sources. Surface and subsurface soil and groundwater that have been impacted may act as secondary sources of impact through mechanisms such as leaching of chemicals from soil, groundwater recharge to surface water and wind and mechanical erosion of chemicals in soil.

3.1.2 Retention or Transport Media

The medium directly impacted by past industrial activities is soil. Dust is considered a potential transport medium, because chemicals in soil may become entrained in fugitive dust. Surface runoff is considered a transport medium, because storm events may have generated episodic overland flow and carried chemicals away from disposal or spill areas.

3.1.3 Transport Pathway

Release mechanisms and transport pathways were evaluated for the Site. Listed below are potential cross-media transfer mechanisms of chemicals:

- Chemicals in subsurface soil may enter groundwater through infiltration/percolation;
- Chemicals in surface soil may be transported to surface water and sediments through surface runoff;
- Chemicals in groundwater may be transported to surface water and sediments through groundwater discharge;
- Chemicals in groundwater may become uncovered as surface water when a trench is excavated in Kreher park soils;
- Chemicals in surface soil may be transported to the atmosphere via volatilization or fugitive dust emission;
- Chemicals in soil or groundwater may be transported to the atmosphere or indoor air through volatilization;
- Chemicals in surface water and sediments may be transported to fish tissue through bioconcentration; and
- Chemicals in sediments may be released to surface water when agitated.

3.1.4 Receptors and Exposure Scenario

Presented below is an overview of populations of potential concern selected for further evaluation in this HHRA. Potential receptors are discussed based on medium of interest (i.e., soil, groundwater, sediment, surface water, biota, and air). Updates to the receptor populations identified in the Final RI/FS Work Plan (URS, 2005) are discussed as necessary.

3.1.4.1 Exposure to COPCs in Soil

Residential Land Use Scenario: **Child and Adult Residents**

Upper Bluff - There is a residential area located up gradient from the Kreher Park area of the Site on the upper bluff area near the former ravine. Described below were three exposure scenarios assumed in this HHRA for the residential receptors:

- **Exposure to surface (0-1 ft) and subsurface soil (1-10 feet bgs)** This assumption was made because new construction would involve excavation of soil for the construction of basements. Therefore, subsurface soil would be brought to the surface resulting in a potential exposure pathway for residential receptors. This scenario represents the worst case for residential receptors, but is not likely to be the actual scenario associated with the Site.
- **Exposure to surface soil** The residential neighborhoods adjacent to the Site are established neighborhoods and are expected to remain in the future. According to the Ashland Wisconsin Waterfront Development Plan, the future use of the Kreher Park portion of the Site does not include a residential scenario. In an established residential setting and without intrusive activities, receptors would most likely be exposed to surface soil only.
- **Exposure to soil in 0-3 ft bgs** For informational purposes, COPCs in soil between 0 and 3 ft bgs were also considered for residential receptors based on the assumption that receptors could potentially be exposed to soil in 0-3 ft bgs when performing landscaping or gardening activities.

For the purpose of this HHRA, child and adult residents are assumed to be exposed to COPCs in soil via incidental ingestion, inhalation (of soil-borne vapor and particulates) and dermal contact pathways.

Recreational Use Scenario: Child, Adolescent and Adult Visitors

Kreher Park is now comprised of City parkland. Child, adolescent and adult visitors are assumed to be exposed to COPCs in surface soil via incidental ingestion, inhalation (of soil-borne vapor and particulates) and dermal contact pathways.

Industrial/Commercial Land Use Scenario: Maintenance Workers

Although the Final RI/FS Work Plan (URS, 2005) indicated maintenance workers currently access the Site, additional information collected during the implementation of the RI/FS Work Plan indicates that City workers and utility maintenance personnel do not access the Site. However, the City may develop the existing marina and expand it into the affected area for recreational use. Therefore, a potential future maintenance worker was considered a receptor to surface soil at Kreher Park and the unpaved portions of the Upper Bluff area. It is conservatively assumed that maintenance workers may be exposed to COPCs in surface soil via incidental ingestion, inhalation (of soil-borne vapor and particulates) and dermal contact pathways.

Industrial/Commercial Land Use Scenario: General Industrial Workers

Except for the NSPW facility, no other industrial/commercial facilities exist within the Site. For this HHRA, general workers are defined as NSPW employees involved with non-intrusive, operational activities. Current and potential future general workers are not likely to be subject to significant exposure to environmental media in the normal course of their daily work. Although the potential for exposure to occur is expected to be low, general workers are assumed to be exposed to COPCs in surface soil via incidental ingestion, inhalation (of soil-borne vapor and particulates) and dermal contact pathways.

Industrial/Commercial Land Use Scenario: Construction Workers

Upper Bluff and Kreher Park - It is conservatively assumed that construction activities could take place at every area included in this evaluation and it is possible for construction workers to be exposed to COPCs detected in surface and subsurface soil samples collected from the Site via incidental ingestion, inhalation (of soil-borne vapor and particulates) and dermal contact pathways. For this HHRA subsurface soil is defined as a depth of 10 feet or less, which is a conservative estimate of the limit to which construction activities may occur based on the current and proposed future land use at the Site.

For informational purposes, a hot spot analysis was performed for construction worker using soil data collected from the Former Coal Tar Dump. The results of this analysis are presented in Section 6.6.

3.1.4.2 Exposure to COPCs in Indoor Air – Residents and Industrial Workers

Upper Bluff - There is a residential area located up gradient from the Kreher Park area of the Site on the upper bluff area, near the former ravine. For the purpose of this HHRA child and adult residents are assumed to be potentially exposed to COPCs volatilizing from soil and groundwater and entering the residences located near the ravine. In addition, potential exposures to COPCs in indoor air were also evaluated for industrial workers who may enter the NSPW service center/vehicle maintenance building periodically.

3.1.4.3 Exposure to COPCs in Groundwater

Trespassing Land Use Scenario: **Trespassers**

The RI/FS Work Plan indicated that groundwater in the seep area was a potential exposure point for trespassers. However, this exposure point has been eliminated because highly impacted soil was removed from the former seep area and the area was capped as part of the 2002 interim action response (URS, 2002). Therefore, this exposure pathway is no longer complete and was not quantitatively evaluated in the HHRA.

Another potential point of exposure described in the RI/FS Work Plan was COPCs in groundwater in the former WWTP building where affected groundwater has infiltrated into the basement. The building is locked and the perimeter is partially fenced. A quantitative evaluation for the potential trespasser exposures to the indoor air and water inside the former WWTP building was not performed due to the lack of data. No water samples were collected from the building. In 2002, a consultant for the City of Ashland inspected the inside of the WWTP building and collected a single round of indoor air samples to address potential inhalation exposure to City of Ashland workers. Samples were only analyzed for limited chemicals (selected PAHs, trimethylbenzene and acetic acid). The results of this sampling indicated that Site-related compounds are probably in the indoor air of the former WWTP building, and a thorough indoor air investigation was recommended before final re-use decisions (WDHFS, 2003).

Although access to the WWTP remains unrestricted, the potential for dermal, inhalation, and incidental ingestion exposure to COPCs in groundwater seepage inside the WWTP building is considered low because the building is locked and the perimeter is partially fenced. If, however, it is deemed necessary to quantitatively evaluate trespasser exposure to COPCs in indoor air from groundwater seepage inside the building, indoor air and water samples should be collected for laboratory analyses for Site-related COPCs to support the development of a quantitative evaluation.

Residential and Industrial/Commercial Land Use Scenarios

Groundwater contamination is present in both a shallow aquifer and a confined deep aquifer. Currently the shallow groundwater is not used as a potable water source. There are two artesian wells in the Site vicinity—one located near Prentice Avenue on the eastern boundary of the Site and the other located near the marina on the western boundary. Both wells draw water from the Copper Falls aquifer, which is a deep aquifer separated from the shallow groundwater by the Miller Creek Formation (URS, 2005; ATSDR, 2003). As precautionary measure, the City of Ashland temporarily closed these wells for public use in August 2004. To date water from these wells have met all federal and state safe drinking water standards. Water from these artesian wells is considered safe to drink as Site-related chemicals have not been detected in these wells at levels of concern (ATSDR, 2003).

Except for the two artesian wells at Kreher Park, the Copper Falls aquifer is not used for drinking water and is not considered a source of human exposure. Shallow groundwater at the Site is not a drinking water source for the City of Ashland. Drinking water at the Site is provided by the City of Ashland that draws its water from intakes in Lake Superior, located approximately one mile northeast of the Site and is outside the known extent of surface water contamination. Therefore, there are no known ingestion receptors to shallow groundwater beneath the Site.

Industrial/Commercial Land Use Scenario: Construction Workers

Kreher Park - It is conservatively assumed that in the future construction activities may take place within Kreher Park and it is possible for construction workers to be exposed to oily materials in groundwater via the dermal contact, inhalation, and incidental ingestion pathways when performing excavation activities below the water table. Because oily materials in groundwater were not sampled during the RI, concentrations of chemicals in “oily water” were based on a derived concentration using the laboratory analytical data of the dense non-aqueous

phase liquid (DNAPL) samples collected from the product stream recovered from the active free product recovery system for the Copper Falls aquifer (Appendix D6 of the RI report) and chemical-specific solubility values of chemicals detected in the DNAPL sample.
Kreher Park, Upper Bluff, Filled Ravine – It is conservatively assumed that trenching activities could take place within Kreher Park, the Upper Bluff, and the Filled Ravine resulting in construction/excavation worker exposure to COPCs in trench air. Because there is no data which measures the concentrations of VOCs in trench air, the maximum detected groundwater concentration within each domain was used to model a trench air concentration to which construction/excavation workers might be exposed. Attachment J of the HHRA, presents the proposed trench air concentrations.

3.1.4.4 Exposure to COPCs in Surface Water and Sediments

Recreational Use Scenario: **Adolescent and Adult Visitors**

Kreher Park and Chequamegon Bay Sediments – The Site is located and surrounded by facilities that draw the public to the lakefront – a City marina, public swimming beach, a boat ramp and an RV park and campground. Adolescent and adult visitors are assumed to be exposed to COPCs in surface water and sediments via incidental ingestion and dermal contact pathways while swimming, wading, fishing, or boating. However, only risks associated with swimming and wading activities were quantified in the HHRA. This is because they represent activities that have the greatest contact with impacted media and are considered more conservative than exposures associated with fishing and boating.

Evaluating exposures to contaminated surface water has been challenging at the site due to a limited number of samples collected when natural factors caused the release of tar slicks. On November 15, 2005, during RI sampling activities, surface water samples were collected shortly after a tar slick was reported and photographed by a citizen, however, no slicks were observed by sample collectors and the subsequent data does not indicate notable surface water impacts. However, based on a single surface water sample collected in January 1998, the 1998 SEH report calculated unacceptable levels of current and future health risks for workers, trespassers, and people engaged in recreational activities on the site. Since this exposure pathway poses one of the greatest potential health risks at the site, the revised HHRA report includes an evaluation of exposures to “oil slicks” in surface water as well as an evaluation of exposures to surface water using the 1998 SEH data. Because no samples of the “oil slick” have been collected, this exposure medium and associated pathways were evaluated using:

- Laboratory analytical data of the DNAPL samples collected from the product stream recovered from the active free product recovery system for the Copper Falls aquifer (**Attachment I1**)
- Chemical-specific solubility values of chemicals detected in the DNAPL sample (**Attachment I2**).

The use of this alternative data in evaluating exposure to COPCs in surface water has limitations and uncertainties, and is very conservative. A discussion of the limitations and uncertainties associated with the use of this data is provided in **Section 6**.

3.1.4.5 Exposure to COPCs in Fish Tissue

Subsistence Fishing Scenario: **Adult Subsistence Fisher**

Impacted Sediment Areas – Adult subsistence fishers were selected as the fishing receptors because there are two Chippewa Bands (the Bad River Band and the Red Cliff Band of Lake Superior Chippewa) who may use Chequamegon Bay as their source of fish. For this HHRA it is conservatively assumed that adult subsistence fishers may be exposed to COPCs via ingestion of locally-caught fish. Although this scenario was selected based on the presence of the two Chippewa Bands, this exposure scenario and the selected exposure parameters are applicable to any subsistence fisher ingesting fish from Chequamegon Bay. **Attachment A** provides detailed information regarding the exposure parameters used and their sources.

Presented below is an overview of receptors of potential concern selected for further evaluation in this HHRA. Potential receptors are discussed based on medium of interest (i.e., soil, sediment, surface water, biota, and air). A detailed discussion of the risks associated with each receptor population is presented in **Section 5.1.**

SUMMARY OF PATHWAYS EVALUATED IN HHRA							
Receptor Pathway	**Media of Interest[a]**						
	Surface Soil	**Subsurface Soil**	**Sediment**	**Surface Water**	**Indoor Air**	**Groundwater**	**Biota**
Industrial/Commercial Exposure Scenario/General Industrial Workers:							
Inhalation of airborne COPCs	FMGP				SCB		
Incidental ingestion of COPCs	FMGP						
Dermal contact with COPCs	FMGP						
Industrial/Commercial Exposure Scenario/ Construction Worker:							
Inhalation of airborne COPCs	KP FMGP	KP FMGP					
Incidental ingestion of COPCs	KP FMGP	KP FMGP					
Dermal contact with COPCs	KP FMGP	KP FMGP					
Dermal contact with COPCs in “oily water”						KP	
Incidental ingestion of COPCs in “oily water”						KP	
Inhalation of COPCs in Trench Air[b]						KP UB FR	
Industrial/Commercial Worker Exposure Scenario/Maintenance Worker:							
Inhalation of airborne COPCs	KP UB	KP UB					
Incidental ingestion of COPCs	KP UB	KP UB					
Dermal contact with COPCs	KP UB	KP UB					
WWTP Trespassing Land Use Scenario							
Inhalation of airborne COPCs						KP	
Incidental ingestion of COPCs						KP	
Dermal contact with COPCs						KP	
Recreational Exposure Scenario/Children:							
Inhalation of airborne COPCs	KP						
Incidental ingestion of COPCs	KP						
Dermal contact with COPCs	KP						
Recreational Exposure Scenario/Adolescents:							
Inhalation of airborne COPCs	KP						
Incidental ingestion of COPCs	KP						
Dermal contact with COPCs	KP						
Recreational Exposure Scenario/Adults:							
Inhalation of airborne COPCs	KP						
Incidental ingestion of COPCs	KP						
Dermal contact with COPCs	KP						
Recreational Exposure Scenario/Swimmer & Wader/Adults:							
Incidental ingestion of COPCs			CB	CB			
Dermal contact with COPCs			CB	CB			
Incidental ingestion of COPCs in oil slicks”				CB			

SUMMARY OF PATHWAYS EVALUATED IN HHRA							
Receptor Pathway	Media of Interest[a]						
	Surface Soil	Subsurface Soil	Sediment	Surface Water	Indoor Air	Groundwater	Biota
Dermal contact with "oil slicks"				CB			
Recreational Exposure Scenario/Swimmer & Wader/Adolescents :							
Incidental ingestion of COPCs			CB	CB			
Inhalation of airborne COPCs					UB		
Dermal contact with COPCs			CB	CB			
Incidental ingestion of COPCs in oil slicks"				CB			
Dermal contact with "oil slicks"				CB			
Subsistence Fisher Exposure Scenario:							
Ingestion of COPCs in fish							CB
Off-site Residential Exposure Scenario:							
Inhalation of airborne COPCs	UB	UB			UB		
Incidental ingestion of COPCs	UB	UB					
Dermal contact with COPCs	UB	UB					

[a]The data set used to estimate risk for each receptor is defined as indicated below:

- FMGP – Former Manufactured Gas Plant
- KP – Kreher Park
- UB – Upper Bluff
- SCB – Service Center Building
- CB – Chequamegon Bay
- FR – Filled Ravine

[b] For the exposure to COPCs in trench air, it is assumed that workers may inhale COPCs volatilizing from groundwater encountered in the excavated trench (Attachment J).

3.2 QUANTIFICATION OF CHEMICAL INTAKES

Integration of data gathered in the exposure assessment (i.e., the extent, frequency, and duration of exposure for the populations and pathways of concern) into a quantitative expression of chemical-specific intake is necessary to perform a quantitative risk characterization.

The potential for human receptors to be exposed to impacted media through relevant routes of exposure (e.g., inhalation, ingestion and dermal contact) were evaluated. Exposure pathways considered not applicable, based on site-specific information, were excluded from the quantitative evaluation in the baseline HHRA. Rationale for the elimination of exposure pathways is provided in respective sections.

Estimates of intake of COPCs are required for quantitative risk characterization. Described below is the basic equation used to calculate the human intake of COPCs (USEPA, 1989):

$$I = C \times \frac{IR \times EF \times ED}{BW \times AT}$$

Where:

I = Daily intake (mg of chemical per kg of body weight per day)
C = Concentration of COPC (e.g., mg/kg in soil or fish, mg/L in water or mg/m^3 in air)
IR = Intake rate; the amount of contaminated medium contacted over the exposure period (e.g., mg/day for soil and fish, L/day for water and m^3/day for air)
EF = Exposure frequency; describes how often exposure occurs (days/year).
ED = Exposure duration; describes how long exposure occurs (years).
BW = Body weight; the average body weight over the exposure period (kg)
AT = Averaging time; period over which exposure is averaged (days)

Each of the intake variables in the above equation consists of a range of values in the literature. To account for uncertainties associated with parameter values, two separate exposure scenarios were evaluated in this HHRA: a reasonable maximum exposure (RME) scenario and an average case (i.e., central tendency evaluation [CTE]). The RME represents the maximum exposure that is reasonably likely to occur while the CTE is representative of average exposure. The RME scenario was calculated using the 95% upper confidence limit of the arithmetic mean (95% UCLs) concentration and a combination of the mean and upper-bound exposure parameter values. The CTE scenario was calculated using the arithmetic mean concentration as the EPC and the mean exposure parameter values.

General information regarding the formulae and parameter values for pathways evaluated in this HHRA is provided in **Attachment A, Tables 1 - 11** for both the RME and CTE scenarios.

3.3 DISTRIBUTION TESTING AND CALCULATION OF 95% UPPER CONFIDENCE LIMITS

The RI/FS Work Plan (URS, 2005) for the Site provided extensive detail outlining the methodology to be used to test the distribution of each data set and subsequent calculation of the 95% UCLs. For the HHRA, the USEPA guidance "Calculating the Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites" (USEPA, 2002b) and the accompanying ProUCL software (USEPA, 2004c) was used to estimate UCLs. Although the RI/FS Work Plan approach was in compliance with USEPA guidance, it did not indicate that USEPA software would be used to estimate UCLs for the Site, which is the preferred method for estimating 95% UCLs. **Attachment B1** provides summary tables which includes RME EPCs for each receptor data set evaluated. RME output from the ProUCL software (USEPA, 2004c) is presented in **Attachment B2**. A summary of the EPCs used for the CTE scenario are presented in **Attachments E**. A summary of the EPCs and associated ProUCL output tables for evaluations discussed in the Uncertainty Analysis (Section 6) is presented in **Attachments F1** and **F2**, respectively.

For this HHRA, distribution testing and UCL calculations were attempted when the sample population was greater than five and the percentage of nondetects was 15% or less. For data sets not meeting these criteria, the maximum detected concentration was selected as the EPC. For evaluating health impacts potentially associated with exposures to lead using either the Integrated Exposure Uptake Biokinetic Model (IEUBK) for Lead (USEPA, 1994; USEPA, 2005b) or the Adult Lead Model (ALM) (USEPA, 2003a), the average concentration of lead was used, in accordance with the USEPA guidance.

3.4 GROUNDWATER AND SURFACE WATER CONCENTRATION TERMS

Oily materials in groundwater or slicks in surface water were not sampled during the RI. For the purpose of this evaluation, concentrations of chemicals in “oily water” were based on the following:

- Laboratory analytical data of the dense non-aqueous phase liquid (DNAPL) samples collected from the product stream recovered from the active free product recovery system for the Copper Falls aquifer (**Attachment I1)**.
- Chemical-specific solubility values of chemicals detected in the DNAPL sample (**Attachment I2**).

3.5 TRENCH AIR CONCENTRATION TERMS

No data is available for assessing risk to construction/excavation workers exposed to VOCs in trench air at Kreher Park, the Upper Bluff, or the Filled Ravine. Therefore, the maximum detected concentrations in groundwater for each of these domains was used to model a concentration in trench air using equations presented as part of the Virginia Department of Environmental Quality risk assessment guidance (VADEQ, 2006).

The toxicity assessment provides a framework for characterizing the relationship between the magnitude of exposure to a chemical and the nature and likelihood of adverse health effects that may result from such exposure. In an HHRA, chemical toxicity is typically divided into two categories: carcinogenic and noncarcinogenic effects of concern. Potential health effects are evaluated separately for these two categories, because their toxicity criteria are based on different mechanistic assumptions and associated risks are expressed in different units. Provided in this subsection is an overview of the methodology used to develop a toxicity assessment as part of the HHRA for the Site.

4.1 SOURCES OF TOXICITY INFORMATION

Pertinent toxicological and dose-response information for chemicals were selected from the following sources, in accordance with USEPA guidance (USEPA, 2003b):

- Tier 1 – Integrated Risk Information System (IRIS), available on-line (USEPA, 2006)
- Tier 2 – USEPA's Provisional Peer-Reviewed Toxicity Values (PPRTVs)
- Tier 3 – Other toxicity values (e.g., California Environmental Protection Agency, the

Agency for Toxic Substances and Disease Registry (ATSDR), and USEPA's Health Effects Assessment Summary Tables (HEAST) (USEPA, 1997b).

4.2 METHODOLOGY FOR EVALUATING CARCINOGENIC EFFECTS

For purposes of assessing risks associated with potential carcinogens, the USEPA has adopted the science policy position of "no-threshold;" i.e., there is essentially no level of exposure to a carcinogen which will not result in some finite possibility of tumor formation. This approach requires the development of dose-response curves correlating risks associated with given levels of exposure. Linear dose-risk response curves are generally assumed.

Carcinogenic risks associated with a given level of exposure to potential carcinogens are typically extrapolated based on slope factors (SFs) or unit risks. SFs are the upper 95% confidence limit of the slope of the dose-response curve, expressed in terms of risk per unit dose [given in $(mg/kg\text{-}day)^{-1}$]. Unit risks relate the risk of cancer development with the concentration of carcinogen in the given medium, expressed as either risk per unit concentration in air [given in $(\mu g/m^3)^{-1}$] or drinking water [given in $(\mu g/L)^{-1}$].

Current USEPA Superfund guidance for calculating a dermal SF is to adjust the oral SF with an oral absorption factor specific for that chemical. It should be noted that the oral absorption factor used in the calculation refers to absorption of the chemicals in the species upon which the SF is based; i.e., generally not absorption data in humans.

The equation for extrapolation of a default dermal SF is as follows:

$$\text{Default Dermal SF}\left[(\text{mg/kg - day})^{\ 1}\right] = \text{Oral SF}\left[(\text{mg/kg - day})^{\ 1}\right] \div \text{Oral Absorption Factor}\ (\%)$$

4.3 METHODOLOGY FOR EVALUATING NON-CARCINOGENIC EFFECTS

The USEPA has adopted the science policy position that protective mechanisms (such as repair, detoxification, and compensation) must be overcome before the adverse systemic health effect is manifested. Therefore, a range of exposures exists from zero to some finite value that can be tolerated by the organism without appreciable risk of expressing adverse effects.

The approach used by the USEPA to gauge the potential non-carcinogenic effects is to identify the upper boundary of the tolerance range (threshold) for each chemical and to derive an estimate of the exposure below which adverse health effects are not expected to occur. Such an estimate calculated for the oral route of exposure is an oral reference dose (RfD), and for the inhalation route of exposure is an inhalation reference concentration (RfC). The oral RfD is typically expressed as mg chemical per kg body weight per day, and the inhalation RfC is usually expressed in terms of concentration in the air (i.e., mg chemical per m^3 of air). However, for purposes of baseline HHRAs, inhalation RfC values can be converted to units of dose by multiplying by the inhalation rate (20 m^3/day, an upper-bound estimate for combined indoor-outdoor activity) and dividing by the body weight (70 kg, average body weight), as detailed in the following equation:

$$\textit{Inhalation}\ \text{RfD}\ (\text{mg/kg - day}) = \text{RfC}\ (\text{mg/m}^3) \times 20\ {}^{m^3}\!\!/_{day} \div 70\ \text{kg}$$

Currently, two types of oral RfDs/inhalation RfCs are available from the USEPA, depending on the length of exposure being evaluated (chronic or subchronic). Chronic oral RfDs/inhalation RfCs are specifically developed to be protective for long-term exposure to a compound, and are generally used to evaluate the non-carcinogenic effects associated with exposure periods between seven years (approximately 10% of an average lifespan) and a lifetime. Subchronic oral

RfDs/inhalation RfCs are useful for characterizing potential non-carcinogenic effects associated with shorter-term exposures. Current guideline for Superfund program risk assessment requires that subchronic oral RfDs/inhalation RfCs be used to evaluate the potential non-carcinogenic effects of exposure periods between two weeks and seven years.

Toxicological criteria specifically derived for gauging potential human health concerns associated with the dermal route of exposure has not been developed by USEPA. For purposes of this HHRA, default dermal RfD values were extrapolated from oral RfDs (USEPA 1989), if:

- Health effects following exposure are not route-specific.
- Portal-of-entry effects (e.g., dermatitis associated with dermal exposure and respiratory effects associated with inhalation exposure) are not the principal effects of concern.

Exposures with the dermal route are generally calculated as absorbed doses, while oral RfDs are expressed as administered doses. Current USEPA Superfund guidance is to adjust the oral RfD with an oral absorption factor (i.e., percent chemical that is absorbed) to extrapolate a default dermal RfD, which is expressed in terms of absorbed dose. It should be noted that the oral absorption factor used in the calculation refers to absorption of the chemicals in the species upon which the RfD is based (i.e., generally not absorption data in humans).

The equation for extrapolation of a default dermal RfD is as follows:

$$\textit{Default}\ \text{Dermal RfD}\left(\text{mg/kg - day}\right) = \text{Oral RfD}\left(\text{mg/kg - day}\right) \times \text{Oral Absorption Factor}\left(\%\right)$$

Toxicity values (both SFs and RfDs) used in this HHRA are provided in **Attachment A**, **Tables 12a** and **12b**.

4.4 TOXICOLOGICAL PROFILE FOR COPCS

Toxicological profiles are included for all selected COPCs. Toxicological profiles prepared by the ORNL and available through the online Risk Assessment Information System (RAIS) are presented in **Attachment C** on compact discs. For those chemicals for which an ORNL toxicological profile is unavailable on RAIS, an ATSDR toxicological profile was included. For chemicals without either an ORNL or an ATSDR toxicological profile, information from the National Library of Medicine's Hazardous Substance Data Bank is provided.

4.5 EVALUATING EXPOSURES TO LEAD

Because most human health effects data for lead are correlated with concentrations in the blood rather than an external dose, the traditional approach for evaluating health effects cannot be applied to lead. Lead is therefore evaluated separately from carcinogens and noncarcinogens.

USEPA has developed a model for predicting the effect of lead exposure on blood lead concentrations in children exposed to lead – the IEUBK model (IEUBK Windows v1.0 build 261, [December 2005b]). The IEUBK Model is used to predict the risk of elevated blood lead levels in children (under age seven) that are exposed to environmental lead from many sources. The model estimates the risk that a typical child, exposed to specified media lead concentrations, will exceed a certain level of concern (10 micrograms per deciliter [µg/dL]) (USEPA, December 2005b). The target criterion for lead risk is 5% or less of child residents with an estimated blood lead level in excess of 10 µg/dL. The 10 µg/dL value is the "concern threshold" recommended by the U.S. Centers for Disease Control and Prevention (CDC) (ATSDR, July 1999).

The IEUBK model was run using site-specific lead concentrations in soil and default values for all other parameters (**Attachment A, Table 13**).

USEPA has also developed an ALM (version 05/19/2003) that can be applied to adult worker receptors. The ALM is currently the accepted and standard model to assess adult non-residential exposures to lead in soil and indoor dust. The model uses a simplified representation of lead biokinetics to predict quasi steady-state blood lead concentrations among adults who have relatively steady patterns of site exposures. The methodology focuses on estimating fetal blood lead concentrations in female workers. All the equations in the model are used to calculate target concentrations based on the probability of exceeding a blood lead level of 10 µg/dL for a fetus. Lead risks are considered unacceptable for a non-residential (worker) receptor if the fetal blood lead level for more than 5% of fetuses of adult female workers is estimated to equal or exceed the CDC concern threshold of 10 µg/dL. The ALM model was run using site-specific lead concentrations in soil and default values for all other parameter (**Attachment A, Table 14**).

The ALM is used to evaluate risks of lead exposure to the fetus of pregnant female industrial workers, construction workers, and other workers that are identified as relevant receptors at a site. Other worker standards or guidelines are cited for comparative purposes (ATSDR, July 1999). The Occupational Safety and Health Administration (OSHA) blood lead level of concern in adult workers (all occupations) is 30 µg/dL; the OSHA permissible standard is 40 µg/dL for all workers. OSHA established medical removal criteria for workers of 50 µg/dL, with reentry into the workplace allowed at 40 µg/dL. The American Conference of Governmental Industrial Hygienists (ACGIH) also established a blood lead level of concern of 30 µg/dL in workers.

5.1 RISK CHARACTERIZATION

In this section of the HHRA, toxicity and exposure assessments were integrated into quantitative and qualitative expressions of carcinogenic and noncarcinogenic risks. The detailed estimates of risks are presented numerically in **Attachment D** and are summarized in **Sections 5.1** and **5.2**.

Carcinogenic risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen. In accordance with guidance provided in RAGS, Part A (USEPA 1989), incremental risk of an individual developing cancer can be estimated by multiplying the calculated daily intakes, that are averaged over a lifetime of exposure, by the SFs. This carcinogenic risk estimate represents an upper-bound value since the SF is often an upper 95% confidence limit of probability of response that is extrapolated from experimental animal data using a multistage model.

The potential for noncarcinogenic effects was evaluated by comparing an exposure level over a specified time period with an RfD derived for a similar exposure period. This ratio of exposure to toxicity is referred to as a hazard quotient (HQ). This HQ assumes there is a level of exposure below which it is unlikely even for sensitive populations to experience adverse health effects. If the HQ exceeds one, there may be concern for potential noncancer effects; however, this value should not be interpreted as a probability.

Carcinogenic and noncarcinogenic risk estimates were combined across pathways, as appropriate, to account for potential additive effects. The sum of HQs is termed a hazard index (HI). In general, USEPA recommends a target value or risk range (i.e., HI = 1 or cancer risk [CR] = 10^{-4} to 10^{-6}) as threshold values for potential human health impacts. The WDNR and WDHFS recommend a target value or cancer risk threshold of 10^{-5} and noncancer risk threshold of 1 for potential human health. For the HHRA, risks are compared to both the USEPA, WDNR, and WDHFS target risk values.

When the HI exceeds unity, then the HQs will be segregated based on similarities in target organ effects. Information regarding target organs following exposures to COPCs was retrieved from the following sources:

- Risk Integrated System for Closure. Indiana Department of Environmental Quality.
- Tiered Approach to Corrective Action Objectives. Illinois Environmental Protection Agency.

- *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites.* March 2002. OSWER 9355.4-24 (USEPA, 2002a).

The risk characterization results presented in **Attachment D** for the RME scenario were compared to these target levels and are presented below for all media evaluated. These levels aid in determining the objectives of the baseline HHRA, which include determining whether additional response action is necessary at the Site. These levels provide a basis for determining residual chemical levels that are adequately protective of human health, provide a basis for comparing potential health impacts of various remedial alternatives, and help support selection of the no-action remedial alternative, where appropriate.

5.2 RISK CHARACTERIZATION RESULTS

Risks were compared to both USEPA target risk ranges (CR=10^{-4} to 10^{-6} and HI =1) as well as the target risk thresholds for WDNR. Where the calculated carcinogenic and noncarcinogenic risk exceed the either threshold, it is noted in the text discussion below. **Attachment D** provides a detailed presentation of the carcinogenic and noncarcinogenic risk calculations.

5.2.1 Risk Summary for the Residential Scenario

Risks associated with exposure to surface and subsurface soil for residents are a CR of 5×10^{-4} and an HI of 15 for samples collected within the filled ravine of former MGP. Both the cancer and noncancer risk exceed the USEPA target risk range of 10^{-4} to 10^{-6} and the WDNR threshold of 10^{-5} for cancer and an HI of 1 for noncancer endpoints, respectively. The resulting cancer risk of 5×10^{-4} is primarily attributed to benzo(a)pyrene (65%) and dibenzo(a,h)anthracene (10%). Upon review of the data gathered for benzo(a)pyrene, 10 sampling locations (located in both the filled ravine and the Upper Bluff) with detectable concentrations ranging from 22 to 340 mg/kg at intervals between 1 to 8 feet bgs are the main contributors to the benzo(a)pyrene cancer risk. In addition, one sample location for dibenzo(a,h)anthracene (CP110) with a reported concentration of 3.8 mg/kg (1 to 3 feet bgs) is the main contributor to the dibenzo(a,h)anthracene cancer risk.

The resulting HI of 15 is primarily attributed to naphthalene (with an HI of 11). Detailed calculations of cancer and noncancer risk are presented in **Attachment D**, **Tables 1** through **3**.
Based on the results of the IEUBK model inputting an average lead concentration of 90.5 mg/kg,, the percentage of children predicted to have a blood lead concentration greater than 10

µg/dL is 0.11, which is within USEPA's target criteria of no more than 5% above the concern threshold of 10 µg/dL concentration. The results of the IEUBK are presented in Attachment D, Table 3f. While one location (GP-110 (1-3')) had a highly elevated lead concentration of 4000 mg/kg, only one other sample (GP-115 (1-3') had a concentration (480 mg/kg) that exceeded the screening level of 400 mg/kg. Thus, while there are elevated concentrations are in the loading dock area of the NSPW, the average concentration is below the screening level.

Based on the results of the IEUBK model, the percentage of children predicted to have a blood lead concentration greater than 10 µg/dL is 0.11, which is within USEPA's target criteria of no more than 5% above the concern threshold of 10 µg/dL concentration. The results of the IEUBK are presented in **Attachment D**, **Table 3f**.

5.2.1.1 Indoor Air Pathway

Measured concentrations in soil vapor samples collected from subsurface soil within the filled ravine area of the Site did not exceed the USEPA's risk target shallow soil vapor screening concentrations at a target risk level of 10^{-5} (**Table 17**) indicating that subsurface vapors are not migrating off-site towards the residential area at St. Claire Street and Prentice Avenue.

Summary of RME Carcinogenic and Noncarcinogenic Risks[a]

Receptor	Table	Soil		Oily Materials in Surface Water[d]		Sediment		Oily Materials in Groundwater[d]		Biota		Indoor Air[b, e]	
		CR	HI	CR	HI	CR	HI	CR	HI	CR	HI	CR	HI
Resident	20	**<u>5×10⁻⁴</u>**	**<u>15</u>**	–	–	–	–	–	–	–	–		
Recreational Adult	21	4×10^{-6}	0.002	–	–	–	–	–	–	–	–	–	–
Recreational Adolescent	22	2×10^{-6}	0.003	–	–	–	–	–	–	–	–	–	–
Recreational Child	23	<u>1×10^{-5}</u>	0.04	–	–	–	–	–	–	–	–	–	–
Adult Swimmer	24	–	–	**<u>9×10^{-2}</u>**	**<u>6</u>**	<u>4×10^{-5}</u>	0.05	–	–	–	–	–	–
Adolescent Swimmer	25	–	–	–	–	<u>2×10^{-5}</u>	0.05	–	–	–	–	–	–
Adult Wader	26	–	–	**<u>5×10^{-2}</u>**	**<u>4</u>**	<u>4×10^{-5}</u>	0.05	–	–	–	–	–	–
Adolescent Wader	27	–	–	–	–	<u>2×10^{-5}</u>	0.05	–	–	–	–	–	–
Industrial Worker	28 29	6×10^{-6}	0.007	–	–	–	–	–	–	–	–	**<u>8×10^{-5}</u>**	**<u>3</u>**
Maintenance Worker	30	1×10^{-6}	0.001	–	–	–	–	–	–	–	–	–	–
Construction Worker[c]	31	**<u>1×10^{-4}</u>**	**<u>38</u>**	–	–	–	–	**<u>7×10^{-3}</u>**	**<u>59.5</u>**	–	–	**<u>8.34E-03 (KP)</u>** **<u>2.14E-05 (UB)</u>** **<u>3.29E-02 (FR)</u>**	**<u>17152 (KP)</u>** **<u>228 (UB)</u>** **<u>646601 (FR)</u>**
Subsistence Fisher	32	–	–	–	–	–	–	–	–	**<u>1×10^{-4}</u>**	0.01	–	–

[a] No COPCs were identified for soil gas and surface water. Risks based on exposure to these media were not quantified.
[b] For the industrial worker, the air risks were estimated using indoor air data from sample locations NS-GSINDOOR-0405 and NS-GSINDOOR-0705.
[c] For the construction worker, the groundwater risks were calculated using a derived concentration of "oily materials" in groundwater estimated using the laboratory analytical data of the DNAPL samples collected from the product stream recovered from the active free product recovery system for the Copper Falls aquifer.
[d] Represents the linear low dose risks calculated for both the recreational and construction receptors. The non-linear low dose risks are presented in Attachments I1 and I2. Although calculations of the surface water risks associated with exposures to the 1998 SEH data were completed (Attachment K), only the oily slicks risk results are presented since they represent the most conservative approach.

Risks in bold are greater than the USEPA range for acceptable risk (1×10^{-4} to 1×10^{-6}). Cancer risks that are underlined are greater than the Wisconsin Department of Public Health threshold of 1×10^{-5}.

KP – Calculated using the Virginia Department of Environmental Quality Equation 3-8: Exposure of Workers to Volatiles in a Construction/Utility Trench (Groundwater less than 15 feet deep). Maximum detected concentrations in groundwater from Kreher Park were used as the exposure point concentration. Detailed calculations for this exposure pathway are presented in Attachment J.

UB – Calculated using the Virginia Department of Environmental Quality Equation 3-8: Exposure of Workers to Volatiles in a Construction/Utility Trench (Groundwater less than 15 feet deep). Maximum detected concentrations in groundwater from the Upper Bluff were used as the exposure point concentration. Detailed calculations for this exposure pathway are presented in Attachment J.

FR – Calculated using the Virginia Department of Environmental Quality Equation 3-8: Exposure of Workers to Volatiles in a Construction/Utility Trench (Groundwater less than 15 feet deep). Maximum detected concentrations in groundwater from the Filled Ravine were used as the exposure point concentration. Detailed calculations for this exposure pathway are presented in Attachment J.

5.2.1.2 Residential Risk Discussion

PAHs appear to be the primary risk drivers for the residential receptor within the filled ravine area of the former MGP. The highest concentrations of PAHs, and thus the highest risks, are associated with PAHs detected at depths of 0 to 3 feet bgs. However, residents are not currently located in this area of the Site and residential areas are not likely to be established at this part of the Site in the future.

For this HHRA, it was conservatively assumed that the residential receptors would be exposed to both surface and subsurface soil. This assumption was made because new construction would involve excavation of soil for the construction of basements or foundations. Therefore, soil with high chemical concentrations would be brought to the surface resulting in a potential exposure pathway for residential receptors. This scenario represents the worst case for residential receptors, but is not likely to be the actual scenario associated with the Site. The residential neighborhoods adjacent to the Site are established neighborhoods and are expected to remain in the future. According to the Ashland Wisconsin Waterfront Development Plan, the future use of the Kreher Park portion of the Site does not include a residential scenario. Therefore, residential receptors would only be exposed to surface soil. If it is assumed that residential receptors adjacent to the Site tend gardens, then it is possible that the first three feet of soil will represent the most likely exposure point.

Re-evaluating the residential receptor using EPCs derived based on the exposure to surface soil and soil to a depth of 3 feet indicates that carcinogenic and noncarcinogenic risks within USEPA's target risk range of 10^{-4} to 10^{-6} for cancer endpoints and an HI of 1 for noncancer endpoints. However, the estimated cancer risk for surface soil remains above the WDNR threshold of 10^{-5}.

Receptor	**Table**	**Soil**	
		CR	**HI**
Resident (Surface Soil only)	33	1×10^{-5}	0.2
Residential (0-3 feet bgs)	34	3×10^{-4}	0.9

The resulting CR of 1×10^{-5} for exposure to surface soil only is primarily attributed to arsenic (76%). Upon review of the data, one sampling location (lSS19) with a reported concentration of 8.5 mg/kg is the main contributor to arsenic cancer risk. **Attachment F1**, **Tables 1** through **5,** in **Appendix H** provides a detailed presentation of these calculations.

Seventy eight percent of the resulting CR of 3×10^{-4} (exposure to soil between 0 and 3 feet bgs) is attributed to benzo(a)pyrene. Upon review of the data, 12 sampling locations within the filled ravine area with reported concentrations ranging from 0.19 to 220 mg/kg (at depths greater than 1 foot bgs) are the main contributors to cancer risk. **Attachment F2, Tables 6** through **10** in **Appendix H** provide a detailed presentation of these calculations.

5.2.2 Risk Summary for the Recreational Scenario

The following pathways were considered for the recreational scenarios:

- Recreational adults, adolescent, and children exposed to surface soil
- Recreational adult and adolescent swimmers exposed to surface water
- Recreational adult and adolescent waders exposed to sediment and surface water

In general, risks associated with COPC exposures to surface soils by recreational users were estimated to be with CRs ranging between 1×10^{-5} and 1×10^{-6}, and HIs ranging between 0.002 and 0.04. Risk associated with swimmer and wader exposures to COPCs in sediments were estimated to be with CRs between $1x10^{-5}$ and $3x10^{-9}$, and His between 0.002 and 0.00002. For adult swimmer and wader exposure to oily materials in surface water, CR was $9x10^{-2}$ and $5x10^{-2}$, and HI was 6 and 4, respectively. Risks associated with each medium and recreational receptor are discussed below.

5.2.2.1 Risk Summary for Recreational Users Exposed to Surface Soil

Only limited metals and carcinogenic PAHs were identified as COPCs for recreational user exposure to surface soil. Cancer and noncancer risks to recreational adults and adolescents exposed to surface soil are generally a CR between 1×10^{-6} and 1×10^{-4} and less than an HI of 1. Risks to a recreational child exposed to surface soil are estimated to be a CR of 1×10^{-4}, and an HI of less than 1. The primary risk driver for the recreational adult, adolescent and child is benzo(a)pyrene.

A summary of the risks to the recreational adult, adolescent, and child are provided in **Tables 21**, **22**, and **23**. A detailed presentation of the risk calculations for the recreational adult, adolescent, and child are provided in **Attachment D**, **Tables 4** to **12**.

Recreational Adults

Risks associated with exposure to surface soil for recreational adults are a CR of 4×10^{-6} and an HI of 0.002 for samples collected within Kreher Park. Both the cancer and noncancer risks are within the USEPA target risk range of 10^{-4} to 10^{-6} for cancer and an HI of 1 for noncancer endpoints, respectively. These calculated risks are below the carcinogenic and noncarcinogenic WDNR thresholds (i.e., a CR of 10^{-5} and an HI of 1). Approximately 76% of the resulting CR of 3×10^{-6} is attributed to benzo(a)pyrene. Upon review of the data gathered for benzo(a)pyrene for the Site, four sampling locations (located in Kreher Park, one of which is located within the Former Coal Tar Dump, sample TP-118) with detectable concentrations ranging from 7.4 to 68 mg/kg at intervals between 0 to 1 foot bgs are the main contributors to the benzo(a)pyrene cancer risk.

Detailed calculations of the risks to recreational adults are presented in **Attachment D**, **Tables 4** to **6**.

Recreational Adolescents

Risks associated with exposure to surface soil for recreational adolescents are a CR of 2×10^{-6} and an HI of 0.003 for samples collected within Kreher Park. Both the cancer and noncancer risk are within the USEPA target CR of 10^{-4} to 10^{-6} for cancer and an HI of 1 for noncancer endpoints, respectively. These calculated risks are below the carcinogenic and noncarcinogenic WDNR thresholds.

Approximately 76% of the resulting cancer risk is attributable to benzo(a)pyrene. Upon review of the data gathered for benzo(a)pyrene for the Site, four sampling locations (located in Kreher Park, one of which is located within the Former Coal Tar Dump, sample TP-118) with detectable concentrations ranging from 7.4 to 68 mg/kg at intervals between 0 to 1 foot bgs are the main contributors to the benzo(a)pyrene cancer risk.

Detailed calculations of the risks to recreational adolescents are presented in **Attachment D**, **Tables 7** to **9**.

Recreational Children

Risks associated with exposure to surface soil for recreational children are a CR of 1×10^{-5} and an HI of 0.04 for samples collected within Kreher Park. Both the cancer and noncancer risks are within the USEPA target CR range of 10^{-4} to 10^{-6} for cancer and an HI of 1 for noncancer endpoints, respectively. The calculated carcinogenic risk is equal to the carcinogenic WDNR threshold, but less than the noncarcinogenic WDNR threshold. Approximately 74% of the resulting cancer risk is attributed to benzo(a)pyrene. Upon review of the data gathered for benzo(a)pyrene for the Site, four sampling locations (located in Kreher Park, one of which is located within the Former Coal Tar Dump, sample TP-118) with detectable concentrations ranging from 7.4 to 68 mg/kg at intervals between 0 to 1 foot bgs are the main contributors to the benzo(a)pyrene cancer risk.

Detailed calculations of the risks to recreational children are presented in **Attachment D**, **Tables 10** to **12**.

5.2.2.2 Risk Summary for Recreational Swimmers Exposed to Sediment and Surface Water

Surface water in Chequamegon Bay has a number of issues associated with the existing data set. First, the 2005 surface water data does not confirm the 1998 SEH sampling data which indicates that carcinogenic PAHs are present at concentrations greater than screening levels. Second, oil slicks have been visually observed within Chequamegon Bay. No analytical data is available which measures the levels of chemicals which might be present in oil slick surface water. Therefore, surface water exposures were evaluated using both the 1998 SEH data and analytical data collected from the product stream from the active free product recovery system for the Copper Falls aquifer or chemical-specific solubility values detected in the DNAPL sample. This approach was used to provide a range of risks associated with the 1998 SEH sampling data and the “oil slicks.”

Adult and Adolescent Swimmers Exposed to Surface Water

WHFS calculated the risks associated with exposures to the 1998 surface water data. Because no COPCs were identified in the 2005 RI data set, only the 1998 data were used for estimating risks. Detailed calculations using 1998 surface water data and exposure parameters consistent with the Site are presented in **Attachment K**, **Tables 1** to **6** and are summarized below for the recreational adult and adolescent swimmers.

Receptor	**Calculated Risks Using 1998 SEH Surface Water Data**	
	Cancer Risk	**Noncancer Risk**
Adult Swimmer	6×10^{-5}	NE
Adolescent Swimmer	3×10^{-5}	NE

NE – Not evaluated. Only carcinogenic PAHs were present in surface water at concentrations greater than the RBSC.

Adult Swimmers Exposed to Oil Slicks in Surface Water

Risks associated with exposures to oil slicks in surface water were evaluated. This pathway was evaluated because a tar slick was reported and photographed by a citizen. Although, no slicks were observed by sample collectors and the subsequent data do not indicate notable surface water impacts, the 1998 SEH report calculated unacceptable levels of current and future health risks for workers, trespassers, and people engaged in recreational activities on the site. Since this exposure pathway poses one of the greatest potential health risks at the site, the revised HHRA report includes an evaluation of exposures to "oil slicks" in surface water in addition to the evaluation of the 1998 SEH data.

Risks associated with exposures to oil slicks in surface water were estimated for the recreational swimmers using concentrations of DNAPLs collected from the product stream recovered from the active free product recovery system for the Copper Falls aquifer. Risks associated with exposure to oil slicks in surface water are a CR of 9×10^{-2} and an HI of 6. The primary carcinogenic risk drivers are benzo(a)pyrene (62%) and dibenzo(a,h)anthracene (29%). The primary noncarcinogenic risk drivers are 2-methylnaphthalene (54%), naphthalene (12%) and benzene (16%).

Detailed calculations of the risks to adult swimmers exposed to oil slicks are presented in **Attachment I1**, **Tables 1** to **6**. **Attachment I2** provides detailed calculations using the chemical-specific solubility values.

Adult Swimmers Exposed to Sediment

Risks associated with exposure to sediment for adult swimmers are a CR of 4×10^{-5} and an HI of 0.05 for samples collected within Chequamegon Bay. Both the cancer and noncancer risk are within the USEPA target risk range of 10^{-4} to 10^{-6} for cancer and an HI of 1 for noncancer endpoints, respectively. However, the cancer risk is greater than the WDNR target risk of 1×10^{-5}.

Detailed calculations of the risks to adult swimmers are presented in **Attachment D**, **Tables 13** and **14**.

Adolescent Swimmers Exposed to Oil Slicks in Surface Water

Risks associated with exposures to oil slicks in surface water were evaluated. This pathway was evaluated because a tar slick was reported and photographed by a citizen. Although, no slicks were observed by sample collectors and the subsequent data does not indicate notable surface water impacts, the s SEH report calculated unacceptable levels of current and future health risks for workers, trespassers, and people engaged in recreational activities on the site. Since this exposure pathway poses one of the greatest potential health risks at the site, the revised HHRA report includes an evaluation of exposures to "oil slicks" in surface water in addition to the evaluation of the 1998 SEH data.

Risks associated with exposures to oil slicks in surface water were estimated for the recreational swimmers using concentrations of DNAPLs collected from the product stream recovered from the active free product recovery system for the Copper Falls aquifer. Risks associated with exposure to oil slicks in surface water are a CR of 9×10^{-2} and an HI of 6. The primary carcinogenic risk drivers are benzo(a)pyrene (62%) and dibenzo(a,h)anthracene (29%). The primary noncarcinogenic risk drivers are 2-methylnaphthalene (54%), naphthalene (12%) and benzene (16%).

Detailed calculations of the risks to adolescent swimmers exposed to oil slicks are presented in **Attachment I1**, **Tables 7** to **12**. **Attachment I2** provides detailed calculations using the chemical-specific solubility values.

Adolescent Swimmers Exposed to Sediment

Risks associated with exposure to sediment for adolescent swimmers are a CR of 2×10^{-5} and an HI of 0.05 for samples collected within Chequamegon Bay. Both the cancer and noncancer risk are within the USEPA target risk range of 10^{-4} to 10^{-6} for cancer and an HI of 1 for noncancer endpoints, respectively. However, the cancer risk is greater than the WDNR target risk of 1×10^{-5}.

Detailed calculations of the risks to adolescent swimmers are presented in **Attachment D**, **Tables 15** and **16**.

5.2.2.3 Risk Summary for Recreational Waders Exposed to Sediment and Surface Water

Surface water in Chequamegon Bay has a number of issues associated with the existing data set. First, the 2005 surface water data does not confirm the 1998 SEH sampling data which indicates that carcinogenic PAHs are present at concentrations greater than screening levels. Second, oil slicks have been visually observed within Chequamegon Bay. No analytical data is available which measures the levels of chemicals which might be present in oil slick surface water. Therefore, surface water exposures were evaluated using both the 1998 SEH data and analytical data collected from the product stream from the active free product recovery system for the Copper Falls aquifer or chemical-specific solubility values detected in the dense non-aqueous phase liquid (DNAPL) sample. This approach was used to provide a range of risks associated with the 1998 SEH sampling data and the "oil slicks."

Adult and Adolescent Waders Exposed to Surface Water

WDNR calculated the risks associated with exposures to the 1998 surface water data. Because no COPCs were identified in the 2005 RI data set, only the 1998 data were used for estimating risks. Detailed calculations using 1998 surface water data and exposure parameters consistent with the Site are presented in **Attachment K**, **Tables 1** to **6** and are summarized below for the recreational adult and adolescent waders.

Receptor	**Calculated Risks Using 1998 SEH Surface Water Data**	
	Cancer Risk	**Noncancer Risk**
Adult Wader	$4{\times}10^{-5}$	NE
Adolescent Wader	$2{\times}10^{-5}$	NE

NE – Not evaluated. Only carcinogenic PAHs were present in surface water at concentrations greater than the RBSC.

Adult Waders Exposed to Oily Slicks in Surface Water

Risks associated with exposures to oil slicks in surface water were estimated for the adult waders using concentrations of DNAPLs collected from the product stream recovered from the active free product recovery system for the Copper Falls aquifer. Risks associated with exposure to oil slicks in surface water are a CR of 5×10^{-2} and an HI of 4. The primary carcinogenic risk drivers are benzo(a)pyrene (62%) and dibenzo(a,h)anthracene (29%). The primary noncarcinogenic risk drivers are 2-methylnaphthalene (54%), naphthalene (12%) and benzene (16%).

Detailed calculations of the risks to adult swimmers exposed to oil slicks are presented in **Attachment I1**, **Tables 13** to **18**. **Attachment I2** provides detailed calculations using the chemical-specific solubility values.

Adult Waders Exposed to Sediment

Risks associated with exposure to sediment for adult waders are a CR of 4×10^{-5} and an HI of 0.05 for samples collected within Chequamegon Bay. The cancer risk is within the USEPA target risk range of 10^{-4} to 10^{-6} for cancer and noncancer risk is less than the target HI of 1 for noncancer endpoints. However, the cancer risk is greater than the WDNR target risk of 1×10^{-5}.

Approximately 82% of the resulting cancer risk is attributable to benzo(a)pyrene. Upon review of the data gathered for benzo(a)pyrene for the site, three sampling locations (2200N-1600E, 2250N-1400E, 2400N-1200E) with detectable concentrations ranging from 10.5 to 26 mg/kg at intervals between 0 to 2 feet bgs are the main contributors to the benzo(a)pyrene cancer risk.
Detailed calculations of the risks to adult waders are presented in **Attachment D**, **Tables 17** and **18**.

Adolescent Waders Exposed to Oil Slicks in Surface Water

Risks associated with exposures to oil slicks in surface water were estimated for the adult waders using concentrations of DNAPLs collected from the product stream recovered from the active free product recovery system for the Copper Falls aquifer. Risks associated with exposure to oil slicks in surface water are a CR of 2×10^{-2} and an HI of 4. The primary carcinogenic risk drivers are benzo(a)pyrene (62%) and dibenzo(a,h)anthracene (29%). The primary noncarcinogenic risk drivers are 2-methylnaphthalene (54%), naphthalene (12%) and benzene (16%).

Detailed calculations of the risks to adult swimmers exposed to oil slicks are presented in **Attachment I1**, **Tables 19** to **24**. **Attachment I2** provides detailed calculations using the chemical-specific solubility values.

Adolescent Waders Exposed to Sediment

Risks associated with exposure to sediment for adolescent waders are a CR of 2×10^{-5} and an HI of 0.05 for samples collected within Chequamegon Bay. The cancer risk is within the USEPA target risk range of 10^{-4} to 10^{-6} for cancer and an HI of 1 for noncancer endpoints. However, the cancer risk is greater than the WDNR target risk of 1×10^{-5}.

Approximately 82% of the resulting cancer risk is attributable to benzo(a)pyrene. Upon review of the data gathered for benzo(a)pyrene for the Site, three sampling locations (2200N-1600E, 2250N-1400E, 2400N-1200E) with detectable concentrations ranging from 10.5 to 26 mg/kg at intervals between 0 to 2 feet bgs are the main contributors to the benzo(a)pyrene cancer risk.

Detailed calculations of the risks to adolescent waders are presented in **Attachment D**, **Tables 19** and **20**.

5.2.3 Risk Summary for the Construction Worker Scenario

Soil Exposures

PAHs appear to be the primary cancer risk drivers for the construction scenario within the Kreher Park area of the Site. Of the calculated CR of 1 x 10^{-4}, approximately 71% is attributable to benzo(a)pyrene and 11% is attributable to dibenzo(a,h)anthracene. Upon review of the data, 27 sampling locations (located in both the filled ravine and Kreher Park) with detectable concentrations ranging from 205 to 3,000 mg/kg at intervals between 1 to 8 feet bgs are the main contributors to the benzo(a)pyrene cancer risk. In addition, 24 sample locations for dibenzo(a,h)anthracene (located in Kreher Park) with an detectable concentrations ranging from 28 to 250 mg/kg (2 to 8 feet bgs) are the main contributors to the dibenzo(a,h)anthracene cancer risk. Detailed calculations of the construction scenario cancer risks are provided in **Attachment D**, **Tables 21** to **23**.

The resulting HI of 38 is primarily attributed to naphthalene (with an HI of 31) and 2-methylnaphthalene (with an HI of 1). Because the HI exceeds 1, the noncancer risk for this receptor was re-calculated based on target organs affected by each chemical. **Table 31** shows that target organ-specific HI is greater than 1 for respiratory and systemic target organ effects. Detailed calculation of the construction scenario noncancer risks are provided in **Attachment D**, **Tables 21** to **23**.

Based on the results of the ALM, the percentage of developing fetuses predicted to have a blood lead concentration greater than 10 µg/dL is 1.5, which is within USEPA's target criteria of no more than 5% of fetuses of adult female workers above the concern threshold of 10 µg/dL. The results of the ALM are presented in **Attachment D**, **Table 3f.**

Based on the results of the ALM inputting an average lead concentration of 88.7 mg/kg, the percentage of developing fetuses predicted to have a blood lead concentration greater than 10 µg/dL is 1.5, which is within USEPA's target criteria of no more than 5% of fetuses of adult female workers above the concern threshold of 10 µg/dL. The results of the ALM are presented in Attachment D, Table 3f. While one location (GP-110 (1-3')) had a highly elevated lead concentration of 4000 mg/kg, only one other sample (GP-115 (1-3') had a concentration (480 mg/kg) that exceeded the screening level of 400 mg/kg. Thus, while there are elevated concentrations are in the loading dock area of the NSPW, the average concentration is below the screening level.

For this HHRA, it was assumed that the construction receptors would be exposed to both surface and subsurface soil. This assumption was made based on the definition of the construction scenario (USEPA, 2002a), which would involve the construction of residential or commercial structures at the Site. This represents the worst case scenario and is not likely to occur at the Site given both its current and future land use. Kreher Park is an established park and is expected to remain in the future. Any expansion to the recreational areas of the Site would likely be associated with activities such as the installation of landscaping, sidewalks, and parking lots all of which do not involve excavation to significant depths (USEPA, 2002a). Therefore, construction receptors would most likely be exposed to shallow soils.

A hot spot analysis was performed for the construction scenario using data collected from the following locations near the Former Coal Tar Dump. The results of this analysis are presented in **Section 6.6**.

Location	Sample ID	Depth (feet)
TP-4	1040	4-6
TP-4	933	4-6
TP112	NS-GWTP112-0605	4.5-5
TP112	NS-SOTP112-0-1-061405	0-1
TP112	NS-SOTP112-5	4.5-5
TP112	NS-SOTP112.5-AD	4.5-5
TP113	NS-SOTP113-0-1-061405	0-1
TP113	NS-SOTP113-4	3.5-4
TP115	NS-SOTP115-0-1-061305	0-1
TP115	NS-SOTP115-4	3.5-4
TP115	NS-SOTP115-4-AD	3.5-4
TP116	NS-SOTP116-0-1-061305	0-1
TP116	NS-SOTP116-3	2.5-3
TP118	NS-GWTP118-0605	3.5-4
TP118	NS-SOTP118-3	0-1
TP118	NS-SOTP118-3	3.5-4
TP119	NS-SOTP119-0-1-061305	0-1
TP119	NS-SOTP119-5	4.5-5

Groundwater Exposures

Cancer and noncancer risks associated with the exposure to "oily materials" in groundwater are 7×10^{-3} and 60, respectively. Benzo(a)pyrene (64 percent) and dibenzo(a,h)anthracene (27%) are the primary carcinogenic risk drivers. The primary noncarcinogenic risk drivers are 2-methylnaphthalene (54%), naphthalene (12%), and benzene (16%).

Detailed calculations for this receptor are provided in **Attachment I1**, **Tables 25** to **31**. **Attachment I2** provides detailed calculations using the chemical-specific solubility values.

Trench Air

Cancer and noncancer risks associated with exposure to VOCs in trench air are presented below.

Domain	Trench Air	
	CR	**HI**
Kreher Park	8.34×10^{-3}	17152
Upper Bluff	2.14×10^{-5}	228
Filled Ravine	3.29×10^{-2}	646601

The primary cancer risk drivers at Kreher Park are benzene (77%) and benzo(a)pyrene (23%). The primary risk driver at the Upper Bluff is benzene (100%). The primary risk driver at the Filled Ravine are benzene (47%) and benzo(a)pyrene (53%).

Detailed calculations for this receptor are provided in **Attachment J**, **Tables 1** to **2(A-C)**.

5.2.4 Risk Summary for the General Industrial Worker

For the industrial worker, samples collected within a 0-2 foot depth interval should be included in the 0-1 ft dataset, as the average sample depth was 1 foot (i.e., , GP-137, GP-131, GP-120). An conservative evaluation of the risks was performed using the average concentration of benzo(a)pyrene at these locations as the EPC since the concentrations of these samples were greater than maximum detected concentration within the industrial worker dataset. Risks from ingestion and dermal contact exposure were calculated. . Cancer and noncancer risks associated Cancer and noncancer risks associated with the exposure to surface soil for the general industrial worker receptor are a CR of 1×10^{-6} and an HI of 0.007. Cancer and noncancer risks associated with exposure to indoor air are a CR of 8×10^{-5} and an HI of 3, respectively. The primary cancer risk drivers are trichloroethylene (44%) and benzene (3%). The resulting HI of 3 is primarily attributed to 1,2,4-trimethylbenzene with an HI of 2.

The results of these evaluations are summarized in **Tables 28** and **29**. Detailed calculations for this receptor are provided in **Attachment D, Tables 24 - 27**.

5.2.5 Risk Summary for the Maintenance Worker

Cancer and noncancer risks associated with the exposure to surface soil for the maintenance worker receptor are a CR of 1×10^{-6} and an HI of 0.001. Risks for this receptor are within the target risk levels. The results of this evaluation are summarized in **Attachment D**, **Tables 28 – 30**.

Based on the results of the ALM, the percentage of developing fetuses predicted to have a blood lead concentration greater than 10 µg/dL is 1.6, which is within USEPA's target criteria of no more than 5% of fetuses of adult female workers above the concern threshold of 10 µg/dL. A detailed presentation of the ALM for the maintenance worker is provided in **Attachment D, Table 30f**.

5.2.6 Risk Summary for the Subsistence Fisherman

Risks associated with the ingestion of locally-caught fish from Chequamegon Bay is a CR of 1 $\times10^{-4}$, which is just within the USEPA target cancer risk range of 10^{-4} to 10^{-6} for cancer endpoints, but greater than the WDNR threshold of 10^{-5}. Although the primary risk drivers for this scenario are the carcinogenic PAHs (benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[e]pyrene, dibenzo[a,h]anthracene, and indeno[1,2,3-cd]pyrene), individual cancer risks for each detected carcinogenic PAH is between 1×10^{-5} and 1×10^{-6}. The results of this evaluation are summarized in **Table 32**. Detailed calculations for this receptor are provided in **Attachment D, Tables 31a** and **31b**.

5.3 CENTRAL TENDENCY EVALUATION

Quantitative measures of uncertainty involve the calculation of CTE risk estimates. The CTE calculation involves the use of 50th percentile input parameters in carcinogenic and noncarcinogenic risk estimates as opposed to upper-bound values for parameters used in the RME calculations. The 50th percentile parameters are considered representative of the general receptor population. The chemicals driving the RME risk were evaluated using these average exposure assumptions and the arithmetic mean concentration to derive risk for the CTE scenario rather than the upper-bound and 95% UCL concentrations used for the RME scenario. The CTE scenario was only calculated for pathways in which RME risks exceed the target risk goals (i.e., USEPA carcinogenic risks greater than 10^{-4} and an HI greater than1 and WDNR carcinogenic risk of 10^{-5} and an HI greater than 1).

The results of this evaluation are summarized below. Detailed CTE calculations are provided in **Attachment E, Tables 1** through **6** for residential receptors, **Tables 7** through **9** for construction workers, **Table 10** for the industrial worker and **Table 11** for the subsistence fisherman.

Receptor	**Table**	**Soil**	
		CR	**HI**
Resident (0-10 foot soil depth)	35	2×10^{-4}	8
Resident (0-3 foot soil depth)	36	5×10^{-5}	0.3
Resident (0-1 foot soil depth)	37	5×10^{-6}	0.1
Construction Worker	38	2×10^{-5}	26
Industrial Worker (indoor air)	39	2×10^{-5}	1
Subsistence Fisherman	40	3×10^{-6}	0.0003

5.3.1 *Residents (0-10 foot soil depth)*

Approximately 70% of the resulting CR of 1×10^{-4} for residents exposed to soil between 0 and 10 feet is attributable to benzo(a)pyrene. Upon review of the data , 12 sampling locations (located in both the filled ravine and the Upper Bluff) with detectable concentrations ranging from 16 to 340 mg/kg at intervals between 1 to 8 feet bgs are the main contributors to the benzo(a)pyrene cancer risk. The resulting HI of 5 is primarily attributed to naphthalene (with an HI of 3).

5.3.2 Residents (0-3 foot soil depth)

The resulting cancer risk of 5×10^{-5} for residents exposed to 0 to 3 feet of soils is primarily attributed to benzo(a)pyrene (71%). Upon review of the data, three sampling locations (GP-110, GP-113, and GP-115) with detectable concentrations ranging from 7.8 to 220 mg/kg at intervals between 1 to 3 feet bgs are the main contributors to the benzo(a)pyrene cancer risk. The resulting HI of 0.3 is below the target criterion for the HI of 1.

5.3.3 Residents (0-1 foot soil depth)

The resulting cancer risk of 5×10^{-6} for residents exposed to 0 to 1 feet of soil is primarily attributed to arsenic (79%). Upon review of the data, three sampling locations (SS19, SS15, and SS18) with detectable concentrations ranging from 3.5 to 8.5 mg/kg at in surface soil are the main contributors to the arsenic cancer risk. The resulting HI of 0.1 is below the target criterion for the HI of 1.

5.3.4 Construction Worker

The resulting CR of 2×10^{-5} is primarily attributed to benzo(a)pyrene and dibenz(a,h)anthracene. Approximately 82% of the resulting cancer risk is attributable to benzo(a)pyrene (71%) and to dibenzo(a,h)anthracene (11%). Upon review of the data, 30 sampling locations (located in the filled ravine, the Upper Bluff, and Kreher Park) with detectable concentrations ranging from 130 to 3,000 mg/kg at intervals between 1 to 8 feet bgs are the main contributors to the benzo(a)pyrene cancer risk. In addition, 23 sample locations for dibenzo(a,h)anthracene (located in Kreher Park) with an detectable concentrations ranging from of 28 to 250 mg/kg (2 to 8 feet bgs) are the main contributors to the dibenzo(a,h)anthracene cancer risk. The resulting HI of 26 is primarily attributed to naphthalene with an HI of 23.

5.3.4. Industrial Worker

Cancer and noncancer risks associated with exposure to indoor air for industrial workers are a CR of 2×10^{-5} and an HI of 1, respectively. Both the cancer and noncancer risks are within USEPA target levels of 10^{-4} to 10^{-6} for cancer risk and an HI of 1, but greater than the WDNR cancer threshold of 10^{-5}.

Attachment F2, **Table 10a** and **10b** provide detailed calculations for cancer and noncancer risks. **Table 39** summarizes the CTE for this receptor.

5.3.5 Subsistence Fisherman

Cancer and noncancer risks associated with ingestion of locally-caught fish by a subsistence fisher are a CR of 3×10^{-6} and an HI of 0.0003, respectively. Both the cancer and noncancer risks are within USEPA's target risk levels of 10^{-4} to 10^{-6} for cancer risk and an HI of 1 and less than the WDNR cancer threshold of 10^{-5} and noncancer threshold of 1. The primary risks driver is benzo(a)pyrene with a cancer risk of 2×10^{-6}.

Attachment F2, **Tables 11a** and **11b** provide detailed calculations for cancer and noncancer risks. **Table 40** summarizes the risks estimated for this receptor.

6.1 OVERVIEW

In any HHRA, estimates of potential carcinogenic risk and noncarcinogenic health effects have numerous associated uncertainties. The primary areas of uncertainty and limitations are qualitatively discussed. Areas of uncertainty that are discussed in the RI report include, but are not limited, the following:

- Data collection and evaluation;
- Assumptions regarding exposure scenarios;
- Applicability and assumptions of models selected to predict the fate and transport of COPCs in the environment; and
- Parameter values for estimating intake of COPCs.

Each type of uncertainty is discussed in the sections that follow.

6.2 DATA COLLECTION AND EVALUATION

6.2.1 Residential Scenario Evaluation

For this risk assessment it was assumed that the residential receptors would be exposed to both surface and subsurface soil. This assumption was made because new construction would involve excavation of soil for the construction of basements. Therefore, soil with high chemical concentrations would be brought to the surface resulting in a potential exposure pathway for residential receptors. This scenario represents the worst case for residential receptors, but is not likely to be the actual scenario associated with the Site. The residential neighborhoods adjacent to the Site are established neighborhoods and are expected to remain so in the future. According to the Ashland Wisconsin Waterfront Development Plan, the future use of the Kreher Park portion of the Site does not include a residential scenario. Therefore, residential receptors would only be exposed to surface soil. If it is assumed that residential receptors adjacent to the Site tend gardens, then it is possible that the first three feet of soil will represent the most likely exposure point.

Re-evaluating the residential receptor using EPCs derived based on the exposure to surface soil or soil to a depth to three feet indicates that carcinogenic and noncarcinogenic risks are as presented below.

Receptor	RME Table	RME		CTE Table	CTE	
		CR	HI		CR	HI
Resident (0 – 10 feet soil depth)	20	5×10^{-4}	15	35	1×10^{-4}	5
Resident (0-1 foot soil depth)	33	1×10^{-5}	0.2	36	5×10^{-6}	0.1
Resident (0 – 3 feet soil depth)	34	3×10^{-4}	0.9	37	5×10^{-5}	0.3

An examination of the analytical data used to derive the carcinogenic and noncarcinogenic risks to residents exposed to surface and subsurface soil to a depth of 3 feet shows that the risks are highest in samples collected between 1 and 3 feet bgs for the samples collected in the courtyard area of the former MGP. Locations GP110 and GP115 had the highest detections of all chemicals identified as COPCs at the 1 to 3 feet depth. An examination of the risks associated with sample location SS-24, which is located between the residence on Lakeshore Drive and the former MGP, shows that both carcinogenic and noncarcinogenic risks are 7×10^{-6} and 0.1, respectively.

Based on this re-evaluation of the data, the risks associated with the residential receptor are most likely overestimated based on the assumptions used to obtain the dataset used to evaluate risk. Based on the current configuration of residential areas adjacent to the Site and the future land use presented in the Ashland Wisconsin Waterfront Development Plan, risks to residential receptors would only be associated with surface soil exposures (i.e., 0-1 foot). Surface soil carcinogenic and noncarcinogenic risks are estimated to be within both the USEPA and the WDNR target risk range.

6.2.2 Indoor Air Evaluation

NSPW Former MGP Facility

Based on the data collected, the indoor air concentrations were as much as an order of magnitude higher than the air concentrations detected in ambient air or soil gas samples. This suggests that vapor intrusion may not be primary source of VOCs detected in the indoor samples. However, because of the nature of the chemicals detected in indoor air samples, ambient air, and soil gas samples, the chemicals detected are somewhat dissimilar (**Table 19**). The chemicals detected in indoor air samples include chemicals that may be associated with solvents rather than chemicals that have been associated with historic activities at the site. There is the possibility that there may be other sources of VOCs (e.g., benzene) within the former MGP facility buildings that may have contributed to the types of chemicals detected in indoor samples. As a conservative measure, all chemicals detected in the indoor air samples were included in the quantitative evaluation and the results of the evaluation suggest that risks to residents are within acceptable USEPA limits.

An HI of 3 was calculated for the worker exposure to indoor air pathway under the RME scenario. This risk level is likely to be an over-estimate because:

- It was estimated using the maximum detected concentrations as the concentrations at points of exposure.
- It was calculated based on the exposure parameters for the industrial/commercial workers (i.e., an individual works at the Site for 8 hours per day, 5 days per week, 50 weeks per year for a total of 25 years). The NSPW Service Center where the indoor air samples were collected, is used as a warehouse; there is an office space inside the building, but used only on a part-time basis.

Former WWTP

Although the approved RI Work Plan (URS, 2005) described that the trespasser scenario to the existing WWTP would be evaluated, a quantitative evaluation for the potential trespasser exposures to indoor air and groundwater seepage inside the WWTP was not performed because no water or indoor air samples were collected from the building during the RI sampling program because of access restrictions. In 2002, a consultant for the City of Ashland inspected the inside of the WWTP building and collected a single round of indoor air samples to address potential inhalation exposure to City of Ashland workers. Samples were only analyzed for limited chemicals (selected PAHs, trimethylbenzene and acetic acid). The results of this sampling suggested that Site-related compounds are probably in the indoor air of the former WWTP building, and a thorough indoor air investigation was recommended before final re-use decisions (WDHFS, 2003). Therefore the risks associated with this exposure pathway are unknown.

6.2.3 Surface Water Evaluation

All surface water data (1998 SEH and 2005 RI) were used to estimate risks to recreational receptors. However, a review of the 1998 SEH data and the 2005 (high-energy and low-energy) data indicates that the 2005 (both high- and low-energy data) did not confirm the presence of site-related chemicals in surface water at concentrations greater than the RBSCs. Because the more recent data collected during the RI do not confirm the 1998 surface water data collected as part of the SEH HHRA, the risks associated with the use of these data likely overestimates potential risks associated with this pathway.

6.3 EXPOSURE ASSESSMENT

6.3.1 Exposure Scenario Assumptions

The assumptions used to identify the exposure scenarios evaluated in the HHRA were based on USEPA guidance, Site history, current land use, and limited information concerning future use of the Site. It is assumed that the primary exposure scenario is recreational for Kreher Park. Based on this land use, other scenarios (maintenance and construction) and pathways were developed. If the City of Ashland changes its decision to expand the recreational areas in the future, the HHRA may need to be revisited to determine the risks associated with the future land use.

6.3.2 Fate and Transport Assumptions

6.3.2.1 Volatilization Factors

Site-specific values needed for calculating volatilization factors (VFs) were unavailable. Therefore, chemical and physical parameters were selected from default values recommended in known literature sources based on the predominant soil type of silty clay. Using this approach to calculate Site-specific VFs may potentially result in an over- or under-estimate of risks if the actual Site-specific chemical and physical parameters are significantly different from default values selected based on the silty clay soil type.

6.3.2.2 Particulate Emission Factors

For the general industrial worker and residential scenarios, it was assumed that the inhalation of fugitive dusts generated by wind erosion was of concern. To estimate risks to this pathway, a particulate emission factor (PEF) is needed to relate the chemical concentration in soil to the concentration of dust particles in the air. For this HHRA, Site-specific values for the wind erosion dispersion factor and non-erodible surface cover were used for the residential and commercial/industrial scenarios. Because the non-erodible surface cover is based on current conditions, the risks estimated may not be representative of conditions with greater or lesser surface cover after the Site is developed for re-use.

For the construction scenario, the PEF was estimated using a combination of default and Site-specific information. USEPA's Supplemental SSL Guidance (USEPA, 2002a) was followed to estimate a PEF for both fugitive dusts associated with vehicular traffic on unpaved roads and for any other construction related activities (e.g., grading, dozing, tilling, wind erosion). Although it is assumed that future construction work will be limited to expansion of the Site as a recreational area, currently there are no plans in place for this work. Therefore, little Site-specific information exists concerning the actual construction activities that may occur. As such, a representative PEF for the Site could not be calculated and the actual PEF could be greater than or less than the estimated value.

Attachment G, **Tables 1** through **14** present the PEF calculations for the commercial/industrial, residential, and construction scenarios. **Attachment G** also provides a detailed presentation of the default and limited Site-specific values used for the derivation of PEF values.

6.3.3 Extrapolation of Vapor Concentrations from Surface Water

There is no methodology available for quantifying concentrations of vapor from surface water available in USEPA guidance. Therefore, risks to recreational receptors exposed to VOCs in surface water were not evaluated quantitatively.

Potential risks associated with exposures to oily slicks in surface water were quantified for the adult swimmer and wader exposure to COPCs (using DNAPL data due to the lack of oily slick data) via the incidental ingestion and dermal contact pathways. Although risks via inhalation of chemicals volatilizing from surface water were not quantified for these exposure scenarios, risks posed by the inhalation pathway is expected to be significantly lower than those associated with the ingestion and dermal pathways.

6.3.4 Receptor Exposure Parameter Values

Although there are future plans for expanding the recreational areas, specific information regarding construction and excavation activities that might occur is unknown. Therefore, risks to construction worker receptors based on the assumptions used in this HHRA may over- or under-estimate risks to this receptor population.

Additionally, little information is available concerning the maintenance work that is completed at the Site currently and none is available for future maintenance activities. The assumptions regarding the exposure frequency for maintenance workers is a based on seasonal weather patterns. The actual risks to this receptor are unknown but the estimates presented in this HHRA are based on conservative assumptions.

6.3.5 Exposure Point Concentrations

6.3.5.1 Indoor Air

In general, EPCs used in the RME were based on statistically-derived concentrations calculated using USEPA's ProUCL software with two notable exceptions. For indoor air, two samples were collected for the purpose of evaluating risk to potential receptors. Because a UCL could not be calculated with only two samples, the maximum concentration was used as the EPC. Use of the maximum detected concentration may potentially overestimate risk associated with exposure to indoor air. However, the true risk is unknown.

6.3.5.2 Oily Material and Oil Slicks

Information regarding chemical-specific concentrations in oily water is unavailable because oily water (groundwater or surface water containing slicks) was not sampled during previous investigations. To complete a quantitative evaluation of health risks potentially posed by oily material, concentration terms used in this evaluation included the analytical data of the DNAPL and chemical-specific solubility values. The use of these concentrations may result in an overestimate of risks calculated for the oily material.

Oil sheens are typically the lighter fraction of Site hydrocarbons, i.e., short chain alkenes, VOCs, and perhaps sole low molecular weight polycyclic aromatic hydrocarbons (PAHs). Since high molecular weight PAHs are too insoluble and/or are crystalline in nature they are probably not part of the sheens observed. While sheens are visually obvious, the concentrations of the hydrocarbons in sheen are not necessarily high.

Appearance of Oil on Water	Estimated Hydrocarbon Concentration (mg/L)
Barely visible	0.05
Silver sheen	0.1
First trace of color	0.2
Bright bands of color, iridescent	0.4
Colours tending to be dull	1.2
Colours fairly dark, rainbow tints	2.4
Brown or black	12
Brown / dark brown	120

As indicated by the above table, concentration terms used in this evaluation (DNAPL data or chemical-specific solubility) are significantly higher than estimated levels of total hydrocarbon concentrations in the 0.2 to 2.4 mg/L range, based on colors of sheens observed (Doerffer, 1992).. Therefore, estimated risk levels for potential exposures to oily materials in groundwater or slicks in surface water represent conservative overestimates and should not be used as the basis for deriving remedial action objectives.

6.3.5.3 Trench Air

Information regarding chemical-specific concentrations in trench air at Kreher Park, the Upper Bluff and the Filled Ravine is unavailable because air samples were not collected during was not sampled during previous investigations. To complete a quantitative evaluation of health risks potentially posed by chemicals volatilizing from groundwater into trench air, the maximum detected groundwater concentration was used to model a trench air concentration using models presented as part of the Virginia Department of Environmental Quality risk assessment guidance (VADEQ, 2006). The use of the maximum detected concentration within each exposure area potentially overestimates risks since groundwater concentrations are not likely to remain static and are subject to mixing within each zone.

6.3.6 Evaluation of Concentrations Exceeding C_{sat}

A separate evaluation was performed by characterizing risks using EPCs that were derived by excluding chemical concentrations in soil that exceeded the chemical-specific C_{sat}. This evaluation was prepared in response to review comments on the draft HHRA report.
For the purpose of this evaluation, C_{sat} values were calculated for chemicals that are in liquid form at the ambient soil temperature (55 degrees Fahrenheit). Chemical concentrations were

compared to the C_{sat} values and EPCs were derived by excluding concentrations that exceeded C_{sat}t values. Cumulative risks calculated using these EPCs are presented on **Tables 41** through **45**. Presented below is a comparison of the results of this evaluation to the risk evaluation using the entire soil dataset.

Scenario	EPCs Derived Based on the Entire Data Set		EPCs Derived by Excluding Concentrations > Csat	
	CR	HI	CR	HI
Residents (0-10 feet)/RME	5×10^{-4}	15	5×10^{-4}	14
Construction Worker (0-10 feet)/RME	1×10^{-4}	38	1×10^{-4}	33
Residents (0-10 feet)/CTE	2×10^{-4}	8	1×10^{-4}	4
Construction Worker (0-10 feet)/CTE	3×10^{-5}	13	2×10^{-5}	9
Residents (0-3 feet)/RME	5×10^{-5}	0.3	3×10^{-4}	0.9

As indicated by this comparison, similar risk levels were calculated using EPCs derived based on all soil data in the relevant data sets or data that excluded concentrations exceeding C_{sat}.

6.3.7 Lack of Established Methodology

The methodology that was developed by the USEPA for quantifying dermal absorption of chemicals in aqueous media and presented in RAGS Part E was used in calculating risks following exposure to "oily material" in groundwater because of a lack of equations and mathematical models developed specifically for oily materials. The use of this approach is likely to introduce uncertainties into the estimated risk values.

6.4 TOXICITY ASSESSMENT

6.4.1 Use of Unverified Toxicity Values

There were several chemicals (as presented in **Attachment A, Tables 11a and 11b**) detected at this site for which there are only provisional toxicity values. The USEPA process for developing provisional toxicity values is inherently conservative and is not subject to the same vigorous review process as toxicity criteria that have been verified. For this HHRA, 2-methylnaphthalene is a risk driver based on its provisional toxicity value. Because the toxicity values are based on limited animal and human data, the true risks associated with these chemicals is not completely known.

6.4.2 Lack of Toxicity Values for Detected Chemicals

There were several chemicals (1-methylnaphthalene, acenaphthylene, benzo[e]pyrene, benzo[g,h,i]perylene, phenanthrene, 1,2,3-trimethylbenzene, p-isopropyltoluene) that were detected at the Site and for which there are no toxicity values. Because of the lack of information available for these chemicals, the true risk to potential receptors at the Site is unknown. However, because these chemicals were detected in areas where primary risk drivers are located, it is likely that if any remediation based on known risk drivers will address chemicals for which there is a lack of toxicity data.

6.5 COMPARISON TO 1998 SEH BASELINE HHRA

In 1998, SEH completed a baseline HHRA for the Site and adjacent near-shore sediments for the WDNR to evaluate the potential existing and future adverse health effects caused by hazardous substance releases from the Site in the absence of any actions to control or mitigate the releases. The current HHRA was completed as part of the requirements for the investigation of a Superfund site. A comparison of the two HHRAs was completed to determine if the collection of additional data during the RI affects the conclusions of the HHRA for the Site. However, it is important to note that the two HHRAs were prepared in accordance with different regulatory framework (NR 700 for the HHRA prepared by SEH and the NCP for the current HHRA), and slightly different receptors, areas of interest, and media were evaluated. Therefore, a point-by-point comparison cannot be completed using the information from the SEH HHRA as it was presented in the 1998 document. Instead, when this occurs specific information, which will allow the end user to determine how the comparisons were made, will be included in the discussion.

6.5.1 Comparison of Media of Interest

The 1998 SEH HHRA identifies groundwater, seep water, surface water, surface soil, subsurface soil, sediment and fish tissue as the media of interest for receptors contacting impacted media at the Site. Since the completion of the 1998 SEH baseline HHRA, two activities have impacted the media of interest for the Site. The results of these activities yielded the following changes to the media of interest for the Site:

- NSPW implemented interim removal actions in 2000 and 2002 to mitigate exposure risks to contaminants and to recover free-product from the deep aquifer. A low-flow pumping system currently extracts free-product from the deep aquifer, treating the entrained groundwater before discharging it to the City of Ashland's sanitary sewer.
- Discharge through the buried pipe in the former filled ravine was the source of the seep at Kreher Park. An extraction well, installed by NSPW at the base of the filled ravine, was part of a larger interim action that included excavation of contaminated materials at the former seep area and placement of a low-permeability cap to eliminate the intermittent seep discharge and mitigate environmental exposure of the associated contaminants.

Therefore, the exposure pathways associated with seep water (ingestion, inhalation and dermal absorption) identified in the 1998 SEH baseline HHRA are no longer complete and were not evaluated for the current HHRA. The media of interest for the current HHRA include groundwater, surface water, sediment, surface soil, subsurface soil and fish. The primary differences between the media evaluated in both reports are associated with the evaluation of the groundwater and surface water.

6.5.1.1 Groundwater

For the SEH HHRA, groundwater was evaluated for receptors exposed to impacted groundwater at the seep area and the utility trench. Data were available to complete a quantitative estimate of risk for groundwater at these locations.

For the current HHRA, "oily materials" in groundwater were evaluated for the construction worker receptor. However, no data, which measures the concentrations of Site-related chemicals, is available to complete a quantitative estimate of risk. In lieu of suitable data, laboratory analytical data of the DNAPL samples collected from the product stream recovered from the active free product recovery system for the Copper Falls aquifer were used. Use of this data is highly conservative and is likely to overestimate risk.

6.5.1.2 Surface Water

For both the SEH HHRA and the current HHRA, measured surface water concentrations were used to evaluate risks to recreational receptors. The 2005 data identifies no COPCs in surface water, while the 1998 data indicates that carcinogenic PAHs are present concentrations greater than RBSCs. In addition, for the current HHRA, recreational adult swimmers and waders were also evaluated for exposures to "oil slicks" in surface water. Because there are no 2005 data available for this evaluation, chemical-specific solubility values of chemicals detected in the DNAPL sample were used to estimate risk. Use of solubility values is highly conservative and is likely to overestimate actual risk.

6.5.1.3 Fish

The SEH HHRA did not evaluate the ingestion of fish pathway using tissue data. Instead, a fish tissue concentration was modeled based on detections of chemicals in the water column. Because only metals were detected in surface water, no organic chemicals were modeled. The current HHRA uses three fish species to determine risks to subsistence fisherman ingesting fish caught in Chequamegon Bay. The current HHRA indicates that risks to subsistence fishermen based on detections of both organic and inorganic chemicals in fish tissue and more accurately represents risk to subsistence fishermen.

6.5.2 Comparison of Exposure Areas

Both the 1998 SEH and the current HHRA divided the Site into subunits in order to group the data and more accurately assess the contaminants to which various populations may be exposed. However, the 1998 SEH HHRA did not address contamination associated with the former filled ravine, the location where some of the highest concentrations of Site-related chemicals have been observed in soil. According to Section 1.2 of the SEH HHRA, the area of evaluation is the "*Ashland Lakefront Property (Kreher Park) and adjacent offshore sediment in Ashland, Wisconsin.*" Additionally the last paragraph of Section 1.2 of the SEH HHRA states:

The HHRA is limited to the 20 acre area described above and is further limited to considering only the upper shallow groundwater table, site soils (both surface and subsurface), and nearshore lake water and shallow sediments. The baseline HHRA does not include evaluation of contamination located in the ravine up gradient to the Ashland Lakefront Property or contaminants located in the lower Copper Falls aquifer.

Therefore, the 1998 SEH baseline HHRA exposure areas were limited to what is now identified as Kreher Park and the near shore area of Chequamegon Bay. Based on the Figure 2 of the SEH HHRA, this 20 acre parcel of land was divided into 4 subunits for evaluation. These subunits include:

- Kreher Park (Site in General)
- Near Shore Lake Area
- Current Utility Trench
- Seep Area

The SEH HHRA did not include the NSPW Garage, Main Office, Storage Yard or the residential area north of the NSPW Garage
The current HHRA domains include:

- Kreher Park
- Chequamegon Bay
- Filled Ravine
- Upper Bluff

The current HHRA does not specifically address a utility trench area for its worker population; however, it does include this area as part of the overall exposure area for workers. Because there are no definite re-use plans that have been developed for the Site, it was assumed in the current HHRA that worker receptors may potentially be exposed to soil throughout the entire impacted area. Because the future land use is unknown, this approach is more conservative than the approach used in the 1998 SEH HHRA

6.5.3 Comparison of Receptors

In general, each HHRA evaluated similar receptors. Except for the trespassing scenario, which was not evaluated quantitatively, the current HHRA is more comprehensive than the 1998 SEH HHRA as it includes more task-specific receptors.

SEH HHRA receptors identified for quantitative risk assessment in both current and future scenarios include:

- Occupational city workers exposed to soil and groundwater
- Recreational adults, children and adolescents exposed to surface soil, surface water, and fish
- Adolescent trespassers exposed to surface soil and groundwater

Current HHRA receptors identified for quantitative risk assessment in current and future land use scenarios include:

- General industrial workers exposed to indoor air
- Maintenance workers exposed to surface soil
- Construction workers exposed to surface soil, subsurface soil and oily material in groundwater
- Recreational adults, children, and adolescents exposed to surface soil, surface water, sediment and "oil slicks" in surface water
- Subsistence fishermen
- Site residents exposed to surface soil, soil (0-3 feet bgs) and surface and subsurface soil (0-10 feet bgs)

The list generated for the current HHRA is more comprehensive than the SEH HHRA because receptors were based on all possible receptors that could potentially be associated with current and future land uses for the impacted area. Specifically, receptor exposures for indoor, oily material in groundwater and oil slicks in surface water were incorporated in to the current report. These pathways, although highly uncertain, provide another measurement of risk for the Site.

6.5.4 COPCs

In general, the classes of COPCs selected for both the SEH HHRA and the current HHRA are similar for soils. The COPCs selected for both HHRAs is limited primarily to carcinogenic and noncarcinogenic PAHs, VOCs, and limited metals in both surface and sediment. It is important to note that the list of COPCs identified for surface soils at the Site in General (Kreher Park) for the SEH HHRA is much shorter than that for the current HHRA. The current COPC list includes at least nine COPCs (4 metals and 5 PAHs) but the SEH HHRA identifies only three VOCs and two metals (Table 2). It is not likely that the minor changes in the COPCs selected make an significant impact of the risk values calculated for the receptors evaluated.

It appears that although, the SEH HHRA identifies COPCs for surface water, these COPCs are limited to metals (copper, iron, and zinc) (Table A-14 of the 1998 SEH HHRA). Although the current HHRA does not identify any surface water COPCs, surface water was conservatively evaluated for exposure to carcinogenic PAHs in selected surface water samples from the 1998 SEH report (**Table 16**) and Site-related chemicals in "oil slicks." Therefore, the approach used for the surface water exposures for the current HHRA is overly conservative as it uses analytical data associated with the active free product recovery system for the Copper Falls aquifer.

It appears that for the SEH HHRA, background values were used to eliminate detections of metals in various media. This approach was not used for the current HHRA. It is important to note that in Tables A-2 and A-3 which present the summary of detected chemicals in the background samples for subsurface soil and surface soil, Site-related organic compounds were detected indicating that the sample locations selected for background may be impacted. Both approaches may potentially underestimate actual site risks in that metals impacting risk are ignored as background when they might be associated with Site-related conditions.

6.5.5 Toxicity Assessment

Since the time the SEH HHRA was completed, toxicity values have either changed or chemicals were added to the database of toxicity values presented as part of USEPA's IRIS. In addition, provisional values from the Superfund Technical Information Center were also made available for use. Specific changes in the toxicity values are presented below:

- Toxicity values were added to the IRIS database. Prior to 2003, no toxicity values were available for 2-methylnaphthalene. For the SEH HHRA, this chemical was selected as a COPC but risks were not estimated.
- No toxicity values were listed for phenol, n-propylbenzene, n-butylbenzene for the SEH HHRA. However, values are now available for phenol on IRIS and provisional values are available for both n-propylbenzene and n-butylbenzene.
- The toxicity values for total xylenes were updated in 2003.
- The toxicity values for naphthalene were updated in 1998.
- The toxicity values for toluene were updated in 2005.
- The toxicity values for benzene were updated in 1998, 2000, and 2003.

The lack of a toxicity value for 2-methylnaphthalene in the 1998 SEH HHRA, most likely resulted in lower calculation of noncarcinogenic risk. The remaining changes to the toxicity values did effect the overall risk, but not as significantly as adding the risks associated with exposures to 2-methylnaphthalene.

Because no toxicity values are available for lead and no models were available for assessing risk to adult receptors exposed to lead, the SEH HHRA only looked at a qualitative review of this metal. However, for the current HHRA the USEPA Adult Lead Model was used to identify if risks associated with occupational lead exposures were unacceptable. In addition, residential child exposures to lead were also evaluated using the Integrated Exposure Uptake Biokinetic model to determine if child exposures to lead were unacceptable.
The differences in the toxicity values presented in the SEH and current HHRAs indicates that the current HHRA includes a more comprehensive quantitative discussion of risk than the SEH HHRA.

6.5.6 Comparison of the Data Sets Used for Evaluation

The number of samples used in the HHRAs differs significantly in that the number of soil samples upon which the current HHRA is based was greater. For the SEH HHRA, the soil data sets (Table 1) indicate that except for subsurface soil at Kreher Park, the data sets were less than 10. This generally resulted in the use of the maximum detected concentration as the EPC used to estimate risk. The use of the maximum detected concentration, although not unacceptable for estimating risk, it results in a high degree of uncertainty in that the actual concentration to which a receptor might be exposed is unknown and the EPC used could either over- or underestimate risk.

The number of samples used for sediment and surface water are similar.

6.5.7 Comparison of Calculated Cancer and Noncancer Risk

In order to compare risks calculated for each HHRA, it is necessary to look at risks using a receptor and exposure scheme that is similar for both HHRAs. For this comparison, the comparison was completed using the receptors and exposure pathways identified in the RI/FS Work Plan (URS, 2005).

The table presented below shows that generally cancer and noncancer risks are within the USEPA target goals of CRs from 10^{-4} to 10^{-6} for cancer risks and an HI of 1 for noncancer risks. When there are calculated risks above USEPA target levels, they were generally for similar receptors (City worker exposed to subsurface soil and construction worker).
There are distinct differences between both HHRAs. These differences include:

- Residential receptors were not evaluated in the 1998 SEH baseline HHRA. No comparisons can be made for this land use scenario.
- Although evaluated for the 1998 SEH baseline HHRA, the former seep area no longer represents a complete exposure pathway because impacted soil was removed prior to the area being capped in 2002. Therefore, the risks estimated are no longer valid. With the elimination of this exposure medium, the differences in the cancer and noncancer risks for recreational receptors exposed to media at Kreher Park, the comparison demonstrates that risks estimated in both HHRAs are similar and are within the USEPA target range for cancer and noncancer risk.
- Although surface water was evaluated for the 1998 SEH baseline HHRA, there were no surface water COPCs identified using the current surface water dataset. The SEH HHRA surface water risks estimated for the swimmers and waders were less than the USEPA target HI less of 1. Surface water risks estimated using the one sample where carcinogenic PAHs were detected shows that the cancer risks were within USEPA's target risk range, but greater than the WDNR target risk level of 1×10^{-5}. It is important to note that the current data set consists of high energy events (i.e., events likely to cause chemicals in the underlying sediment to resuspend Site-related chemicals to surface water) and low energy events (i.e., calm water) that were collected to verify the presence or absence of surface water contamination.
- The differences between the risks estimated for ingestion of fish are most likely because the 1998 SEH baseline HHRA used modeling to develop fish tissue EPCs using surface water data. The current HHRA uses actual fish tissue data to estimate risk and is more representative of Site conditions.
- The worker populations are different between the two HHRAs; therefore, comparisons between the general industrial worker and maintenance worker cannot be completed because they were not evaluated. However, the SEH HHRA utility worker can be compared to the current HHRA construction worker. The notable exposure parameter differences between the two receptors are note below:

Parameter	SEH HHRA Value	Current HHRA Value
Exposure Frequency	30 days/year	250 days/year
Skin Surface Area	1,311 -2,199 cm^2	1,930 cm
Soil Ingestion Rate	160 mg/day	330 mg/day
Inhalation Rate	3.3 m^3/hour	1.5 m^3/hour

Parameter	SEH HHRA Value	Current HHRA Value
Exposure Time	1 hour/day	8 hours/day

In general, the exposure parameter values used for the current HHRA construction worker are more conservative. Therefore, the risks calculated for the current HHRA are inherently more conservative.

- In general, the recreational receptor exposures are similar. The one notable difference is that the SEH HHRA assumes that recreational receptors will ingest fish from the impacted area. The current HHRA evaluates this pathway using a subsistence fisherman to evaluate this exposure pathway. Otherwise the exposure parameters used to estimate risk to recreational receptors are similar and will not affect the overall risk values obtained for the Site.

6.6 HOT SPOT ANALYSIS

A hot spot analysis was performed for the construction worker scenario using data collected near the former tar pit (TP-4, TP113, TP115, TP116, TP118, and TP119). The resulting cancer risk of 4E-06 is primarily attributed to benzo(a)pyrene (72%). Upon review of the data gathered for benzo(a)pyrene for the former tar pit, 8 samples with detectable concentrations ranging from 1,400 – 2,600 mg/kg between 2.5 and 5 feet bgs are the main contributors to the benzo(a)pyrene cancer risk. As a upperbound estimate of risks to a construction worker, the maximum detected concentrations of benzo(a)pyrene (3000 mg/kg) and naphthalene (37000 mg/kg) were also used to evaluate hot spot risk. The risks from ingestion and dermal contact with benzo(a)pyrene was 1.3E-03; the hazard index from ingestion, dermal contact, and inhalation of naphthalene was 972.

A hot spot analysis was performed for the construction scenario using data collected in the vicinity of the Former Coal Tar Dump in Kreher Park (TP-4, TP113, TP115, TP116, TP118, and TP119). This evaluation was completed as a worse case evaluation of potential risks following exposures to elevated concentrations over a short duration when receptors are engaging in activities that may result in greater contact with soil.

The resulting cancer risk of 4×10^{-6} is primarily attributed to benzo(a)pyrene (72%). Upon review of the data gathered for benzo(a)pyrene for the site, 8 samples with reported concentrations ranging from 1,400 to 2,600 mg/kg between 2.5 and 5 feet bgs are the main contributors to the benzo(a)pyrene cancer risk.

6.7 QUANTIFICATION OF DERMAL EXPOSURE TO PAHs

There are no published dermal SFs available for any chemicals in any USEPA database. As indicated in Sections **4.2** and **4.3** of this HHRA, current USEPA guidance recommends converting oral SFs (an administered dose) using an gastrointestinal absorption factor to a dermal SF (an absorbed dose), if a chemical does not cause toxicological effects at the point of contact. However, based on literature evidence, PAHs have been shown to induce systemic toxicity and tumors at distant organs as well as point of contact. For this reason, the current default approach for extrapolating dermal

	1998 SEH Baseline HHRA								2007 HHRA											
	SS		SD		SW		FISH		SS		GW		SD		SW		FISH		Indoor Air	
Receptor[a, b]	CR	HI	CR	HI	CR	HI	CR	HI	CR	HI	CR	HI	CR	HI	CR	HI	CR	HI	CR	HI
Resident	NE	NE	NE	NE	NE	NE	NE	NE	**5×10^{-4}**	**15**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Recreational Adult[d]	–	0.0006	NA	NA	NA	NA	NA	NA	4×10^{-6}	0.002	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Recreational Adolescent[d]	–	0.02	NA	NA	NA	NA	NA	NA	2×10^{-6}	0.003	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Recreational Child[d]	–	0.06	NA	NA	–	5×10^{-5}	NA	NA	1×10^{-5}	0.04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Adult Swimmer	NA	NA	3×10^{-5}	0.1	6×10^{-5}	2×10^{-5}	NA	NA	NA	NA	NA	NA	4×10^{-5}	0.05	**9×10^{-2}**	**6**	NA	NA	NA	NA
Adolescent Swimmer	NA	NA	2×10^{-5}	0.3	3×10^{-5}	4×10^{-5}	NA	NA	NA	NA	NA	NA	2×10^{-5}	0.05	3×10^{-9}	2×10^{-5}	NA	NA	NA	NA
Child Swimmer	NA	NA	3×10^{-5}	0.7	–	2×10^{-4}	NA	NA	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Adult Wader[d]	NA	NA	3×10^{-5}	0.1	4×10^{-5}	NE	NA	NA	NA	NA	NA	NA	4×10^{-5}	0.05	**5×10^{-2}**	**4**	NA	NA	NA	NA
Adolescent Wader[d]	NA	NA	2×10^{-5}	0.3	2×10^{-5}	NE	NA	NA	NA	NA	NA	NA	2×10^{-5}	0.05	NA	NA	NA	NA	NA	NA
Industrial Worker[e]	NA	1.2×10^{-4}	NA	NA	NA	NA	NA	NA	6×10^{-6}	0.007	NA	NA	NA	NA	NA	NA	NE	NE	8×10^{-5}	**3**
Maintenance Worker	NE	NE	NA	NA	NA	NA	NA	NA	1×10^{-6}	0.001	NA	NA	NA	NA	NA	NA	NE	NE	NE	NE
Construction Worker[c]	**2×10^{-4}**	0.5	NA	NA	NA	NA	NA	NA	**1×10^{-4}**	**38**	**7×10^{-3}**	**60**	NA	NA	NA	NA	NE	NE	8.34E-03 (KP) 2.14E-05 (UB) 3.29E-02 (FR)	17152 (KP) 228 (UB) 646601 (FR)
Subsistence Fisher - Adult	NA	NA	NA	NA	NA	NA	–	0.05	NA	NA	NA	NA	NA	NA	NA	NA	**1×10^{-4}**	0.01	NA	NA
Subsistence Fisher – Adol.	NA	NA	NA	NA	NA	NA	–	0.08	NE	NE	NE	NE	NE	NE	NA	NA	NE	NE	NE	NE
Subsistence Fisher - Child	NA	NA	NA	NA	NA	NA	–	0.04	NE	NE	NE	NE	NE	NE	NA	NA	NE	NE	NE	NE

[a] Because each HHRA evaluated different receptor populations, the risks presented above are for receptor populations that were standardized based on the approved RI/FS Work Plan.
[b] Because the seep was capped during the 2002 interim response action, exposures to this medium are no longer complete and were not used in this comparison.
[c] Construction workers were not evaluated in the 1998 SEH baseline HHRA. The values presented for this worker represent the subsurface soil risks for City Workers at the Utility Trench.
[d] Recreational receptor comparison uses only the current risk calculations provided in Attachment K Tables 1 and 6.
[e] Industrial worker comparison uses only the current risk calculations provided in Tables D-5 and D-19 of the SEH HHRA.
SS – soil
SD – sediment
SW – surface water
NA – Not applicable. This is not a relevant exposure medium for this receptor. Refer to **Section 3.1.4** for a discussion of the receptors evaluated for the Site.
NE – Not evaluated. This receptor or exposure medium was not evaluated. A suitable equivalent population could not be determined.
Items in **bold** represent cancer and noncancer risks that are greater than USEPA target levels of 10^{-4} for cancer risks and 1 for noncancer risks. Cancer risks that are underlined are greater than the WDNR threshold of 1×10^{-5}.

SF values are not applicable to PAHs. Therefore, RAGS Part A (USEPA, 1989) and Part E (USEPA, 2004), only recommend a qualitative evaluation of the carcinogenic effects of PAHs. Although a quantitative evaluation for this pathway was completed in this HHRA, as requested by Agencies, the actual cancer risks associated with dermal exposure to PAHs are unknown.

The results of the HHRA indicate that five exposure pathways result in estimated risks that exceed USEPA's target risk levels and seven exposure pathways result in estimated risks that are either equivalent to or exceed the WDNR threshold of $1{\times}10^{-5}$. These exceedances are indicated below.

Exceeds USEPA Threshold (CR $\geq 1{\times}10^{-4}$ or HI >1)	**Exceeds Wisconsin Threshold (CR$\geq 1{\times}10^{-5}$ or HI >1)**
Residents (Soil[0-3 feet and all soil depths] - Cancer)	Residents (Soil[0-3 feet and all soil depths] - Cancer)
–	Residential Child (Soil – Noncancer)
Construction Worker (Soil [0-10 feet bgs]/Groundwater)	Construction Worker (Soil [0-10 feet bgs]/Groundwater)
Construction Worker (Trench Air)	Construction Worker (Trench Air)
Adult Swimmer (Surface Water)	Adult Swimmer (Surface Water)
Adult Wader (Surface Water/Oil slicks)	Adult Wader (Surface Water/oil Slicks/Sediment)
Industrial Worker (Indoor Air)	Industrial Worker (Indoor Air)
Subsistence Fisher (Biota)	Subsistence Fisher (Biota)

These include estimates for the RME scenarios for potential cancer risks and non-cancer risks. These conclusions are based on assumed exposures to soil in the filled ravine area (for residential receptors) and the filled ravine, upper bluff and Kreher Park area (for construction worker receptors), and to indoor air samples collected at NSPW Service Center. Carcinogenic risks based on CTE scenarios indicate that only the residential receptor exposure to soil (all soil depths to 10 feet bgs) are estimated to be at $1{\times}10^{-4}$, the upper-end of the USEPA target risk range or greater than the WDNR threshold. Carcinogenic risks based on the RME scenarios for residential receptor exposure to soils for all depths exceed $1{\times}10^{-4}$; i.e., the upper-end of the USEPA target risk range. Noncarcinogenic risks for the residential receptor (for soil depths 0-1 foot and 0-3 feet bgs) and risks associated with the construction scenario are within acceptable levels. However, residential receptor exposure to subsurface soil is not expected, given the current and potential future land use of the Site. For this Site, residential risks associated with CTE exposures to surface soil (0 to 1 foot bgs) are within the target risk ranges, but the RME exposures exceed the target risk range.

Although the results of the HHRA indicate risks for the construction workers under the RME conditions exceed USEPA's target risk levels, the assumptions used to estimate risks to this receptor were conservative and assumed the worst case. Given both the current and future land use of the Site, it is unlikely that construction workers would be exposed to soil in the filled ravine and Upper Bluff. The most likely scenario for the future construction worker is exposure to soil within 0 to 4 feet bgs in Kreher Park (a typical depth for the installation of underground utility corridors), as most activities associated with the implementation of the future land use would be associated with regrading, landscaping, and road or parking lot construction. However, the depth to groundwater in Kreher Park is relatively shallow due to the lake-filled material comprising most of the park. Consequently, it is possible that construction workers excavating and installing utilities in such underground corridors in certain portions of Kreher Park may encounter COPC impacted sub-surface soils and NAPLs in groundwater.

An HI of 3 was calculated for the general industrial worker exposure to indoor air pathway under the RME conditions. This risk level is likely to be an overestimate because:

- It was estimated using the maximum detected concentrations as the concentrations at points of exposure.
- It was calculated based on USEPA default exposure parameters for the industrial /commercial workers (i.e., an individual works at the Site for 8 hours per day, 5 days per week, 50 weeks per year for a total of 25 years). The NSPW Service Center is used as a warehouse; there is an office space inside the building, but used only on a part-time basis.

Cancer risks to subsistence fisher (finfish) are equivalent to 1×10^{-4}, the upper-end of the USEPA target risk range, and greater than the WDNR threshold of 1×10^{-5}. Noncarcinogenic risk is within acceptable limits for both USEPA and WDNR.

Risks to recreational children (surface soil) are equivalent to 1×10^{-5}, which is the WDNR cancer risk threshold. However, risks to adolescent and adult receptors exposed to surface soil are below the USEPA acceptable risk range and below the WDNR risk threshold.

Risks to waders and swimmers (sediments), industrial workers (surface soil), and maintenance workers (surface soil) are all within USEPA's target risk range of 10^{-4} to 10^{-6} for lifetime cancer risk and a target HI of less than or equal to 1 for non-cancer risk and are less than the WDNR threshold of 1×10^{-5} for lifetime cancer risk and a target HI of less than or equal to 1 for non-cancer risk.

At the request of the WDNR, risks were also estimated for construction workers exposed to "oily materials" in groundwater via dermal contact and swimmers and waders who may be exposed to oil slicks in surface water via ingestion and dermal contact. Because no media-specific concentrations are available for either scenario, risks were estimated using analytical data collected from the product stream from the active free product recovery system for the Copper Falls aquifer or chemical-specific solubility values detected in the DNAPL sample. Risks to construction workers exposed to "oily material" in groundwater and adult swimmers and waders exposed to "oil slicks" in surface water is greater than both the USEPA upper risk range (CR 1×10^{-4} and HI of 1) and than WDNR threshold (CR 1×10^{-5} and HI of 1). However, it is important to note that there is much uncertainty associated with estimating risks to oily material in groundwater or oil slicks in surface water. The primary uncertainties are associated with the lack of:

- Established methodology for estimating this exposure pathway
- Relevant oily material data resulting in the use of DNAPL data that are expected to result in an overestimate of risk.

In accordance with the AOC, the Remedial Action Objectives were prepared to document objectives based upon human health and ecological risk assessment results. This section primarily focuses on the COPCs for each media, potential exposure pathways and receptors, and acceptable contaminant levels, or range of levels (protectiveness), at particular locations for each exposure route. A brief summary of the Ashland Lakefront Site is provided along with an outline of the remedial alternatives process

8.1 INTRODUCTION

The Site contains property owned by NSPW, a portion of Kreher Park, the former Wastewater Treatment Plant (WWTP), and a portion of the Chequamegon Bay inlet area adjacent to Kreher Park. The primary contaminant source is the former manufactured gas plant which previously occupied the NSPW property. In addition, other possible industrial operations might have contributed to the contaminant source at Kreher Park.

Site characterization began in 1989 when apparent contamination was discovered at Kreher Park. The primary contaminants at the Site are derived from tar compounds, including VOCs and PAHs. Soils, groundwater, and offshore sediments have been impacted. Additionally, free-product derived from the tars is present as a non-aqueous phase liquid (NAPL) in the upper reaches of a filled ravine on the NSPW property, at Kreher Park including the former “seep” area, in the off-shore sediments, and in the upper elevations of the deep Copper Falls aquifer. The free-product in the deep aquifer is surrounded by a dissolved phase contaminant plume that extends north from the area of the free-product in the direction of groundwater flow. Although contaminants have migrated down gradient in the underlying Copper Falls aquifer, both the vertical and lateral extent of contamination is limited by strong upward gradients that create artesian conditions at the Lakefront.

NSPW implemented interim removal actions in 2000 to mitigate exposure risks to contaminants and to recover free-product from the deep aquifer. A low-flow pumping system currently extracts free-product from the deep aquifer, treating the entrained groundwater before discharging it to the City of Ashland’s sanitary sewer. Additionally, NSPW installed an extraction well at the base of the filled ravine that was the source of the seep discharge at Kreher Park. This extraction well was part of a larger interim action that included excavation of contaminated materials at the former seep area and placement of a low-permeability cap to eliminate the intermittent seep discharge and mitigate environmental exposure of the associated contaminants.

8.2 CHEMICALS OF POTENTIAL CONCERN

The primary contaminants at the NSPW Site consist of VOCs and SVOCs. Benzene is the most commonly occurring VOC. SVOCs consist predominantly of a group of PAH compounds. The most commonly occurring PAH at the Site is naphthalene. Some metals (lead, thallium and arsenic) and inorganic compounds (cyanides) have also been found, but these are sporadic are not considered significant COPCs.

The baseline revised Human Health Risk Assessment (HHRA) (URS, 2007) used a tiered, risk-based approach to evaluate COPCs for the various exposure scenarios. The results of the HHRA evaluation found the following COPCs for the Site.

In the HHRA, the toxicity assessment provides a framework for characterizing the relationship between the magnitude of exposure to a chemical and the nature and likelihood of adverse health effects that may result from such exposure. Chemical toxicity is typically divided into two categories: carcinogenic and noncarcinogenic. Potential health effects are evaluated separately for these two categories, because their toxicity criteria are based on different mechanistic assumptions and associated risks are expressed in different units. Thus, the COPC list was refined using toxicology, pathways, and exposure during the HHRA for the Site. No COPCs were identified in the HHRA for groundwater because groundwater is not used as a potable water supply, though construction worker exposure to groundwater is possible. At the former Waste Water Treatment Plant (WWTP), trespassers who enter the buildings can potentially inhale vapors and have direct dermal contact with contaminated groundwater and NAPLs that have infiltrated the flooded lower level of the facility. The COPCs identified for surface water include PAHs. The COPCs identified for sediment include metals and PAHs. PAHs were found to be COPCs in fish. Several volatile compounds were identified COPCs in indoor air.

List of COPCs Identified by the HHRA					
Surface Water	**Groundwater**	**Sediment**	**Soil**	**Fish**	**Indoor Air**
Benzo(a)anthracene	1-Methylnaphthalene	Antimony	1-Methylnaphthalene	1-Methylnaphthalene	1,2,4-Trimethylbenzene
Benzo(a)pyrene	2-Methylnaphthalene	Iron	2-Methylnaphthalene		1,4-Dichlorobenzene
Benzo(b)fluoranthene	Acenaphthene	Manganese	Acenaphthene	Benzo(a)anthracene	Benzene
Benzo(k)fluoranthene	Benzo(a)anthracene	Vanadium	Benzo(a)anthracene		Carbon tetrachloride
Chrysene	Benzo(a)pyrene	1-Methylnaphthalene	Benzo(a)pyrene	Benzo(e)pyrene	Trichloroethylene
Dibenzo(a,h)anthracene	Benzo(b)fluoranthene	2-Methylnaphthalene	Benzo(b)fluoranthene	Benzo(b)fluoranthene	
Indeno(1,2,3-cd)pyrene	Benzo(k)fluoranthene	Benzo(a)anthracene	Benzo(k)fluoranthene	Dibenzo(a,h)anthracene	
	Chrysene	Benzo(a)pyrene	Chrysene	Dibenzofuran	
	Dibenzo(a,h)anthracene	Benzo(b)fluoranthene	Dibenzo(a,h)anthracene		
	Dibenzofuran	Benzo(k)fluoranthene	Dibenzofuran		
	Fluoranthene	Indeno(1,2,3-cd)pyrene	Fluoranthene		
	Fluorene	Naphthalene	Fluorene		
	Indeno(1,2,3-cd)pyrene		Indeno(1,2,3-cd)pyrene		
	Naphthalene		Naphthalene		
	Phenanthrene		Phenanthrene		
	Pyrene		Pyrene		
	1,2,4-Trichlorobenzene		1,2,4-Trichlorobenzene		
	1,2,4-Trimethylbenzene		1,2,4-Trimethylbenzene		
	1,3,5-Trimethylbenzene		1,3,5-Trimethylbenzene		
	Benzene		Benzene		
	Ethylbenzene		Ethylbenzene		
	Toluene		Toluene		
	Total Xylenes		n-Butylbenzene		
			sec-Butylbenzene		
			Total Xylenes		
			Arsenic		
			Lead		
			Thallium		

8.3 POTENTIAL EXPOSURE PATHWAYS AND RECEPTORS

The exposure pathway links the sources, types of environmental releases, and environmental fate with receptor locations and activity patterns. Generally, an exposure pathway is considered complete if it consists of the following four elements:

- A source and mechanism of release;
- A transport medium;
- An exposure point (i.e., point of potential contact with an impacted medium); and
- An exposure route (e.g., ingestion) at the exposure point.

Release mechanisms and transport pathways were evaluated for the Site. Listed below are potential cross-media transfer mechanisms of chemicals:

- Chemicals in subsurface soil may enter groundwater through infiltration/percolation;
- Chemicals in surface soil may be transported to surface water and sediments through surface runoff and backfilling;
- Chemicals in groundwater may be transported to surface water and sediments through groundwater discharge;
- Chemicals in groundwater may be infiltrating the lower level of the former WWTP located in Kreher Park;
- Chemicals in surface soil may be transported to the atmosphere via volatilization or fugitive dust emission;
- Chemicals in soil or groundwater may be transported to the atmosphere or indoor air through volatilization;
- Chemicals in surface water and sediments may be transported to the tissues of aquatic organisms or higher trophic levels through bioaccumulation; and
- Chemicals in sediments may be released to surface water when sediments are disturbed.

8.3.1 Human Health Receptors and Exposure Scenario

Presented below is an overview of exposure pathways of potential concern selected for further evaluation in the HHRA. Potential receptors are discussed based on medium of interest (i.e., soil, groundwater, sediment, surface water, biota, and air). Updates to the receptor populations identified in the Final Work Plan (URS, 2005) are discussed as necessary.

8.3.1.1 Exposure to COPCs in Soil

Residential Land Use Scenario: Child and Adult Residents

Upper Bluff - There is a residential area located up gradient from the Kreher Park area of the Site at the upper bluff area northeast of the former ravine. Described below were three exposure scenarios assumed in the HHRA for the residential receptors:

Exposure to surface (0-1 foot) and subsurface soil (1-10 feet bgs).

This assumption was made because new construction would involve excavation of soil for the construction of footings or basements. Therefore, subsurface soil would be brought to the surface resulting in a potential exposure pathway for residential receptors. This scenario represents the worst case for residential receptors, but is not likely to be the actual scenario associated with the Site.

Exposure to surface soil.

The residential neighborhoods adjacent to the Site are established neighborhoods and are expected to remain so in the future. According to the Ashland Wisconsin Waterfront Development Plan, the future use of the Kreher Park portion of the Site does not include a residential scenario. In an established residential setting and without intrusive activities, receptors would most likely be exposed to surface soil.

Exposure to soil in 0-3 feet bgs.

For informational purposes, COPCs in soil between 0 and 3 feet bgs were also considered for residential receptors based on the assumption that receptors could potentially be exposed to soil from 0-3 feet bgs when performing landscaping or gardening activities.

For the purpose of the HHRA, child and adult residents were assumed to be exposed to COPCs in soil via incidental ingestion, inhalation (of soil-borne vapor and particulates) and dermal contact pathways.

Recreational Use Scenario: Child, Adolescent and Adult Visitors

Kreher Park is now zoned as City parkland. Child, adolescent and adult visitors are assumed to be exposed to COPCs in surface soil via incidental ingestion, inhalation (of soil-borne vapor and particulates) and dermal contact pathways.

Industrial/Commercial Land Use Scenario: Maintenance Workers

Although the final Work Plan indicated maintenance workers currently access the Site, additional information collected during the RI indicates that City workers and utility maintenance personnel do not access the Site. However, the City may develop the existing marina and expand it into the affected area for recreational use. Therefore, a potential future maintenance worker was considered a receptor to surface soil at Kreher Park and the unpaved portions of the Upper Bluff area. It is conservatively assumed that maintenance workers may be exposed to COPCs in surface soil via incidental ingestion, inhalation (of soil-borne vapor and particulates) and dermal contact pathways.

Industrial/Commercial Land Use Scenario: General Industrial Workers

Except for the NSPW facility, no other industrial/commercial facilities exist within the Site. For this HHRA, general workers are defined as NSPW employees involved with non-intrusive, operational activities. Current and potential future general workers are not likely to be subject to significant exposure to environmental media in the normal course of their daily work. Although the potential for exposure to occur is expected to be low, general workers are assumed to be exposed to COPCs in surface soil via incidental ingestion, inhalation (of soil-borne vapor and particulates) and dermal contact pathways.

Industrial/Commercial Land Use Scenario: Construction Workers

Upper Bluff and Kreher Park - It is conservatively assumed that construction activities could take place at every area included in this evaluation and it is possible for construction workers to be exposed to COPCs in surface and subsurface soil via incidental ingestion, inhalation (of soil-borne vapor and particulates) and dermal contact pathways. For this HHRA subsurface soil is defined as a depth of 10 feet or less, which is a conservative estimate of the limit to which construction activities may occur based on the current and proposed future land use at the Site.

8.3.1.2 Exposure to COPCs in Indoor Air – Residents and Industrial Workers

Upper Bluff - The residential area located up gradient from Kreher Park at the upper bluff area northeast of the former ravine was evaluated. For the purpose of the HHRA, child and adult residents were assumed to be potentially exposed to COPCs volatilizing from soil and groundwater and entering the residences located near the ravine. In addition, potential exposures to COPCs in indoor air were also evaluated for industrial workers who may enter the NSPW service center/vehicle maintenance building periodically.

Kreher Park – trespassers who enter the former WWTP can potentially inhale vapors released to contaminated groundwater and NAPLs that have infiltrated the flooded lower level of the facility. The potential health risks associated with this exposure pathway was part of the RI/FS work plan (URS, 2005), but was not quantitatively evaluated by the HHRA and is a data gap. This exposure pathway was not quantitatively evaluated because access to the interior of the plant was restricted during the RI/FS study and no samples could be collected. Additionally, earlier indoor air analyses results collected by the City of Ashland (2002) were not available for review as part of the HHRA. Despite this shortcoming, direct contact exposures to NAPL or "free-product" in groundwater may pose an unacceptable health risk.

8.3.1.3 Exposure to COPCs in Groundwater: Trespassing Land Use Scenario

The final Work Plan indicated that groundwater in the seep area was a potential exposure point for trespassers. However, this exposure point was eliminated because the seep area was capped as part of the 2002 interim action response (URS, 2002). This exposure pathway is no longer complete and was not quantitatively evaluated in the HHRA.

Another potential point of exposure to groundwater is the former WWTP building where groundwater has infiltrated into the basement. The building is locked and the perimeter is partially fenced. A quantitative evaluation for the potential trespasser exposures to the indoor air and water inside the former WWTP building was not performed due to the lack of data.

Industrial/Commercial Land Use Scenario: Construction Workers

Kreher Park - It is conservatively assumed that construction activities could take place at every area included in this evaluation and it is possible for construction workers to be exposed to COPCs in shallow groundwater at Kreher Park via incidental ingestion, inhalation of vapors, and dermal contact pathways. For this HHRA, shallow groundwater is defined as a depth of 10 feet or less, which is a conservative estimate of the limit to which construction activities may occur based on the current and proposed future land use at the Site.

Residential and Industrial/Commercial Land Use Scenarios

Groundwater is present in both the water table aquifer and a confined deep aquifer. Currently the shallow groundwater is not used as a potable water source. There are two artesian wells in the Site vicinity—one located near Prentice Avenue on the eastern boundary of the Site and the other located near the marina on the western boundary. Both wells draw water from the Copper Falls aquifer, the confined deep aquifer that is separated from the shallow groundwater by the Miller Creek Formation (URS, 2005; ATSDR, 2003). The City of Ashland restricted public access to these wells for public use in August 2004. To date water from these wells have met all federal and state safe drinking water standards. Water from these artesian wells is considered safe to drink as Site-related chemicals have not been detected in these wells at levels of concern (ATSDR, 2003).

Except for the two artesian wells, the Copper Falls aquifer is not used for drinking water and is not considered a source of human exposure. Shallow groundwater at the Site is not a drinking water source for the City of Ashland. Drinking water at the Site is provided by the City of Ashland that draws its water from intakes in Lake Superior, located approximately one mile northeast of the Site outside the known extent of surface water contamination. Therefore, there are no known receptors to shallow groundwater beneath the Site.

8.3.1.4 Exposure to COPCs in Surface Water and Sediments

Recreational Use Scenario: Child, Adolescent and Adult Visitors to Kreher Park and Chequamegon Bay

The Site is surrounded by facilities that draw the public to the lakefront – a City marina, public swimming beach, a boat ramp and an RV park and campground. Child, adolescent and adult visitors are assumed to be exposed to COPCs in surface water and sediments via incidental ingestion, inhalation of vapors, and dermal contact pathways while swimming, wading, fishing, or boating. However, only risks associated with swimming and wading activities were quantified in the HHRA. This is because they represent activities that have the greatest contact with impacted media and are considered more conservative than exposures associated with fishing and boating.

8.3.1.1 Exposure to COPCs in Fish Tissue

Subsistence fishers were selected as the fishing receptors because there are two Chippewa Bands (the Bad River Band and the Red Cliff Band of Lake Superior Chippewa) who may use Chequamegon Bay as their source of fish. For the HHRA it was conservatively assumed that adult subsistence fishers may be exposed to COPCs via ingestion of locally-caught fish. Although this scenario was selected based on the presence of the two Chippewa Bands, this exposure scenario and the selected exposure parameters are applicable to any subsistence fisher ingesting fish from Chequamegon Bay.

8.3.2 Ecological Receptors and Exposure Scenario

In the BERA (URS, 2006), the potential risk to ecological receptors was evaluated for benthic macroinvertebrates, fish, birds, and mammals. The potential contact points for ecological receptors include surface water, surface soil and food/prey in terrestrial habitats; and, surface water, sediment and food/prey in aquatic and wetland habitats.

Each of these contact points and their respective exposure media were addressed in the BERA.

8.3.2.1 Routes of Entry

The potential routes of entry for ecological receptors are:

- Direct contact: dermal and/or gill absorption;
- Ingestion; and,
- Inhalation.

In the exposure analysis the relationship between receptors at the Site and potential stressors (chemical, biological, or physical entities that may result in adverse effects to one or more receptors or groups of receptors) were evaluated. EPCs used to estimate exposure were calculated as the UCL95 of the exposure medium. EPCs calculated for sediment, soil, or tissue residues were based directly upon the levels of contaminants in these media. There were no COPCs for surface water.

Exposure estimates for birds and mammals were calculated using food web models. Simplified food web models were developed to calculate average daily doses (ADDs) of COPCs that representative receptors experience through exposure to sediment, and surface soil at the Site. The ADD represents the dose of a chemical that a receptor may ingest if it foraged within designated exposure units. ADDs for wildlife receptors are calculated using (1) exposure-point concentrations for prey and media developed for each, (2) COPC-specific bioaccumulation factors or bioaccumulation models for dietary items, and (3) receptor-specific exposure parameters and food chain model assumptions, (e.g., diet composition, foraging area, amount of incidental soil or sediment ingested, etc.).

8.3.2.2 Risk Characterization

Risk Characterization was the final phase of the BERA. In Risk Characterization, the information from the effects and exposure analyses were used to determine a probability of adverse effects to receptors of concern and discuss the strengths, weaknesses, and assumptions in the BERA. Risk estimates (or Hazard Quotients) were developed for each assessment endpoint based upon comparison of site-specific media concentrations and/or estimated ingested contaminant dose estimates (the latter for wildlife) to effects levels (generic criteria, benchmarks and TRVs) for the various ROCs. Finally risk was characterized for each assessment endpoint by integrating the risk estimate with the results of other lines of evidence, if available.

The results of the risk characterization indicated that there are potentially unacceptable impacts to the benthic macroinvertebrate community in aquatic portions of the Site. Two lines of evidence, bulk sediment chemistry and sediment toxicity testing, indicated that the probability of impairment at the community level was likely. Effects observed from the URS field surveys of the existing benthic community indicated effects that were less dramatic than those demonstrated in the laboratory toxicity studies, but interpretation of the field survey data is made very difficult by a high degree of variability and lack of comparability between reference and site stations.

The BERA concluded that the potential for adverse effects to ecological receptors other than benthic macroinvertebrates was not sufficient to result in significant adverse alterations to populations and communities of these ecological receptors.

8.3.3 Remedial Action Objectives

The specific goals of the remedial actions are defined by acceptable contaminant levels, or a range of levels at each location for each exposure route. The acceptable contaminant level (or protectiveness) is determined based on the findings of the HHRA and the BERA. The general goal of these objectives is to protect human health and environmental receptors at risk due to constituents at the site. These objectives are subject to the criteria evaluated in the FS, and include:

- Eliminate or reduce potential risks to human health and to aquatic and terrestrial animals and to the environment from exposure to contaminants;
- Eliminate future migration of contaminants to receptors;
- Eliminate on-site migration of contaminants;
- Eliminate or reduce contaminant migration to Chequamegon Bay;
- Remove or reduce free-product (NAPL) present at the upper bluff (filled ravine/NSPW property and the Copper Falls Aquifer);
- Remove or reduce free product (NAPL) at Kreher Park;
- Remove or reduce free product (NAPL) from the sediments in Chequamegon Bay;
- Minimize short term risk to human health and to aquatic and terrestrial animals and to the environment: from exposure to contaminants during the implementation of the remedial action.

The HHRA was based upon the protection of human health. The BERA was based upon a risk management goal of maintenance (or provision) of soil, sediment, water quality, food source, and habitat conditions capable of supporting a "functioning ecosystem" for the ecological populations inhabiting or using the Site. The HHRA was used to develop RAOs for soil, and the BERA was used to development RAOs for surface water and sediment. Although HHRA results indicate that groundwater is not currently used as a potable water supply, construction workers may encounter groundwater in a trench. RAOs for dissolved phase and free-phase (tar) groundwater contamination were also developed for groundwater. The development of RAOs is described in the following sections. RAOs for site media are summarized below.

The basis and rationale for soil remediation objectives is protection of reasonable future uses. This includes industrial, commercial and utility worker protection and protection of recreational users of Kreher Park. The basis and rationale for groundwater remediation objectives is based on anticipated commercial/industrial and recreational land use. These objectives were developed to eliminate exposure and protect against off-site migration of contaminants. The basis and rationale for surface water remedial objectives are to minimize the potential for contaminant exposure to surface water users and reduce migration of groundwater and sediment contaminants to surface water that could result in exceedance of surface water standards. The basis and rationale for sediment remedial objectives are to protect populations of aquatic organisms, including fish, and to protect against migration of contaminants from sediments to surface water.

Remedial Action Objective Summary by Site Media		
Environmental Media	**Receptor**	**Preliminary Remedial Action Objectives**
Groundwater	Human Health	Protect human health by eliminating exposure (direct contact, ingestion, inhalation) to groundwater with COPCs in excess of regulatory or risk-based standards; reduce contaminant levels in groundwater to meet MCLs and State of Wisconsin Drinking Water Standards
	Environment Ecological Receptors)	Protect the environment by controlling the off-site migration of contaminants in groundwater to surrounding surface water bodies which would result in exceedance of ARARs for COPCs in surrounding surface waters.
		Conduct free product removal to halt or contain the discharge of a hazardous substance or to minimize the harmful effects of the discharge to the air, land or water.
Soil	Human Health	Protect human health by reducing or eliminating exposure (ingestion/direct contact/inhalation) to soil having COPCs representing an excess cancer risk greater than 10^{-6} as a point of departure (with cumulative excess cancer risks not exceeding 10^{-5}) and a hazard index (HI) greater than 1 for reasonably anticipated future land use scenarios.
		Ensure future beneficial commercial/industrial use of the site and recreational use of Kreher Park.
	Environment (Ecological Receptors)	Protect populations of ecological receptors or individuals of protected species by eliminating exposure (direct contact with or incidental ingestion of soils or prey) to soil with levels of COPCs that would pose an unacceptable risk.
		Conduct free product removal to halt or contain the discharge of a hazardous substance or to minimize the harmful effects of the discharge to the air, land or water.
		Protect the environment by minimizing/eliminating the migration of contaminants in the soil to groundwater or to surrounding surface water bodies.
Surface Water	Human Health	Protect human health by minimizing exposures (direct contact, ingestion, inhalation) to surface water that has been impacted by Site-related groundwater and sediment with concentrations of COPCs such that regulatory or risk-based surface water standards have been exceeded.
	Environment (Ecological Receptors)	Protect the environment by controlling the migration of contaminants in groundwater and in sediments to surface water which would result in exceedance of ARARs for COPCs in surface water.
		Reduce Site-related COPC levels in the surface water to meet State of Wisconsin Surface Water Quality Standards.
Sediments	Human Health	Protect human health by eliminating exposure (direct contact, ingestion, inhalation, fish ingestion) to sediment with COPCs in excess of regulatory or risk-based standards.
	Environment (Ecological Receptors)	Protect populations of ecological receptors or individuals of protected species by eliminating exposure (direct contact with incidental ingestion of sediments or of prey) to sediment with levels of COPCs that would pose an unacceptable risk.
		Conduct free product removal to halt or contain the discharge of a hazardous substance or to minimize the harmful effects of the discharge to the air, land or water.

8.3.3.1 HHRA Based Remedial Action Objectives for Soil, Surface Water and Groundwater

The results of the HHRA indicate that only residential exposure pathways (for soil depths between 0 to 3 feet or all soil depths to 10 feet bgs) and construction worker exposure pathways (for soil depths between 0 and 10 feet) are associated with unacceptable risks (Cancer Risk (CR) greater than 10-4 and Hazard Index (HI) greater than 1) based on exposures to soil in the filled ravine area for residential receptors and the Kreher Park area for construction worker receptors. However, residential receptors are not expected to be exposed to subsurface soil given the current and potential future land use of the Site. (Residential land use in Kreher Park is not anticipated, and residential land use in the upper bluff area is located outside the backfilled ravine where contamination has been identified.) For this Site, risks associated with exposures to surface soil are within acceptable risk ranges.

Although the results of the HHRA indicate risks for exposure to soils and the construction worker scenario exceed USEPA acceptable levels, the assumptions used to estimate risks to this receptor were conservative and considered the worst case. Given both the current and future land use of the Site, it is not likely that construction workers would be exposed to subsurface soil at depths beyond 4 feet bgs (a typical depth for the installation of underground utility corridors), as most activities associated with the implementation of the future land use would be associated with subsurface activities such as regrading, landscaping, and road or parking lot construction. The risk for exposure of construction workers to groundwater was based upon exposure to free product (NAPL), using data for NAPL from samples collected from the free product recovery system currently removing free product from the Copper Falls Aquifer. Although exposure of construction workers to free product with concentrations of chemicals similar to what is collected in recovery wells is highly unlikely and introduces substantial uncertainty into quantification of this exposure pathway, this analysis was conducted at EPA's request. The results of this analysis indicated a carcinogenic risk ranging between 3×10^{-5} and 7×10^{-3} and non-carcinogenic (hazard indices) risk of between 2×10^{-1} and 3×10^{3}. However, based on the above discussion, risks to this receptor population from soil and groundwater exposure are most likely overstated.

Risks to recreational users (surface soil), waders and swimmers (sediments), industrial workers (surface soil), and maintenance workers (surface soil) are all within USEPA's acceptable range of 10^{-4} to 10^{-6} (and do not exceed a cumulative risk of 10^{-5}) for CR and 1 for HI. Risks to subsistence fishers (finfish) was at 10^{-4} and risk to a wader contacting surface water ranged from 2×10^{-5} to 6×10^{-5}.

At EPA's request, an analysis of a swimmer or wader incidentally ingesting and dermally contacting oil material (sheens) in surface water was also conducted. Using the same data from the free-product recovery system as described for dermal exposure to construction workers, risks to swimmers and waders exposed to potential oil slicks in surface water were calculated. In the unlikely event a swimmer or wader contacted oily material (sheens) in surface water 12 days a year the CR would range from 4×10^{-3} to 5×10^{-2}. The non-cancer HI ranged from 4 to 7×10^{-2}. The CR to wader or swimmer for incidental ingestion of surface water ranged from 3×10^{-8} to 1×10^{-6}. The non-cancer HI ranged from 2×10^{-4} to 1×10^{-1}. All of these levels assume worst-case conditions and are associated with a high level of uncertainty.

Preliminary Remediation Goals for Soils and Surface Water

Based on the results of the Site-specific HHRA, preliminary remediation goals (PRG) were derived for the following exposure scenarios that exceeded a cumulative cancer risk of 10^{-5} or a cumulative noncancer risk of a hazard index (HI) of 1:

- Construction worker exposure to soil at Kreher Park;
- Residential exposure to soil at the Upper Bluff; and
- Recreational exposure to surface water.

PRGs were derived for chemicals identified as the primary risk drivers using exposure parameters that were used to develop the HHRA. Presented below are chemical-specific acceptable contaminant levels for these exposure scenarios based on target cancer risk goals of 10^{-4} to 10^{-6} and target noncancer risk goals of an HI of 0.1 and 1. PRGs are not developed for fish because remediation is not plausible for fish; rather, risks from consumption is controlled through consumption advisories, and fish contaminant levels will be reduced through sediment remediation. PRGs were not developed for the indoor air pathway; indoor air levels will be reduced through groundwater remediation.

Soil Preliminary Remediation Goals for Construction Workers (mg/kg)					
Chemical	Carcinogenic Effects			Noncarcinogenic Effects	
	CR = 10^{-6}	CR = 10^{-5}	CR = 10^{-4}	HI = 0.1	HI = 1.0
SVOCs					
2-Methylnaphthalene	NA	NA	NA	1.13E + 02	1.13E + 03
Benzo(a)anthracene	2.01E + 00	2.01E + 01	2.01E + 02	1.06E + 04	1.06E + 05
Benzo(a)pyrene	2.01E - 01	2.01E + 00	2.01E + 01	NA	NA
Benzo(b)fluoranthene	2.01E + 00	2.01E + 01	2.01E + 02	NA	NA
Dibenzo(a,h)anthracene	2.01E - 01	2.01E + 00	2.01E + 01	NA	NA
Indeno(1,2,2-cd)pyrene	2.01E + 00	2.01E + 01	2.01E + 02	7.06E + 03	7.06E + 04
Naphthalene	NA	NA	NA	3.81E + 00	3.81E + 01
VOCs					
Benzene	1.4E + 00	1.4E + 01	1.4E + 02	4.11E + 00	4.11E + 01

Soil Preliminary Remediation Goals for Residents (mg/kg)				
Chemical	Carcinogenic Effects		Noncarcinogenic Effects	
	CR = 10^{-5}	CR = 10^{-4}	HI = 0.1	HI = 1.0
SVOCs				
Benzo(a)anthrancene	6.21E + 00	6.21E + 01	NA	NA
Benzo(a)pyrene	6.21E - 01	6.21E + 00	NA	NA
Benzo(b)fluoranthene	6.21E + 00	6.21E + 01	NA	NA
Dibenzo(a,h)anthracene	6.21E - 01	6.21E + 00	NA	NA
Naphthalene	NA	NA	1.70E + 00	1.70E + 01
VOCs				
Benzene	7.37E + 00	7.37E + 01	1.80E + 00	1.80E + 01

Surface Water Preliminary Remediation Goals for Swimmers (mg/L)					
Chemical	Carcinogenic Effects			Noncarcinogenic Effects	
	CR = 10^{-6}	CR = 10^{-5}	CR = 10^{-4}	HI = 0.1	HI = 1.0
SVOCs					
Benzo(a)anthrancene	2.04E - 04	2.04E - 03	2.04E - 02	NA	NA
Benzo(a)pyrene	1.17E - 05	1.17E -04	1.17E - 03	NA	NA
Benzo(b)fluoranthene	1.19E - 04	1.19E - 03	1.19E - 02	NA	NA
Dibenzo(a,h)anthracene	7.72E - 06	7.72E - 05	7.72E - 04	NA	NA
Indeno(1,2,2-cd)pyrene	1.17E - 04	1.17E - 03	1.17E - 02	NA	NA

Preliminary Remediation Goals for Groundwater

No COPCs were initially identified in the HHRA for groundwater because groundwater is not used as a potable water supply. However, exposure to contaminated groundwater and accompanying NAPLs can potentially occur via the following exposure scenarios:

- Construction worker exposure to shallow groundwater infiltrating trenches at Kreher Park; and
- Trespasser exposure to groundwater infiltrating the lower level of the former WWTP.

These pathways are further discussed and the PRGs for direct contact and inhalation of vapors from affected groundwater are presented under Section A.3.3.3 (Remedial Action Objectives for Media with No Exposure Pathways).

The COPCs in sediment included five PAHs, but the cumulative risks estimated for the recreational receptor exposures to sediments were below USEPA's target risk levels.

8.3.3.3 Remedial Action Objectives for Media with No Exposure Pathways

As described in Section 8.3.1.3 above, currently groundwater is not used as a potable water supply in the vicinity of the Site. Potential exposure to shallow groundwater encountered in Kreher Park fill was eliminated when the seep area was capped in 2002. Shallow groundwater encountered in the filled ravine and groundwater in the underlying Copper Falls aquifer is not currently being used for drinking water in the vicinity of the Site[3]. However, construction workers in a trench may be exposed to groundwater contaminants. For any trench excavated at Kreher Park, shallow contaminated groundwater and NAPLs can infiltrate through coarse fill materials and workers who enter the trenches can be exposed through direct dermal contact and inhalation of vapors. At the former WWTP, trespassers who enter the buildings can potentially inhale vapors and have direct dermal contact with contaminated groundwater and NAPLs that have infiltrated the flooded lower level of the facility. The potential health risks associated with

[3] Although no contaminants were detected in samples collected from two artesian wells located in Kreher Park that obtain water from the Copper Falls aquifer, the City of Ashland restricted access to these wells for public use in August 2004. Additionally, the Site is located within the City limits and serviced by a municipal water supply.

these exposure pathways have not been thoroughly evaluated by the HHRA (see Section 8. 3.3.1). Direct contact exposures to NAPL or "free product" in groundwater may pose an unacceptable health risk.

Despite these data gaps, site investigation results indicate that COPCs in the shallow Kreher Park and ravine fill units and groundwater in the underlying Copper Falls aquifer exceed regulatory enforceable groundwater quality standards. PRGs for groundwater were derived primarily from Wisconsin Administrative Code (WAC) chapter NR 140 groundwater quality standards for the most frequently occurring dissolved phase organic COPCs based on historic groundwater monitoring results. The concentrations provided in the table below provide a conservative level that will be further refined in subsequent technical memoranda and the FS.

Preliminary Remediation Goals (µg/l) for Organic COPCs in Groundwater (WAC Chapter NR 140 Enforcement Standard)

COPC – VOCs	ES	COPC – SVOCs*	ES
Benzene	5	Anthracene (LMW)	3,000
Ethylbenzene	700	Benzo(a)Pyrene (HMW)	0.2
Styrene	100	Benzo(b)Fluoranthene (HMW)	0.2
Toluene	1,000	Chrysene (HMW)	0.2
1,2,4-Trimethylbenzene	480**	Fluoranthene (HMW)	400
1,3,5-Trimethylbenzene		Fluorene (LMW)	400
Total Xylenes	10,000	Naphthalene (LMW)	40
		Pentachlorophenol	1
		Pyrene (HMW)	250
		Phenol	6,000

* (HMW) – Heavy molecular weight PAHs; (LMW) – Low molecular weight PAHs

** Trimethylbenzene (TMB) in groundwater will be presented as the sum of 1,2,4- and 1,3,5- TMB per the WAC ch. NR 140 standard.

Inorganic COPCs (metals and cyanide) were also detected above groundwater quality standards. Acceptable contaminant levels for groundwater were derived primarily from WAC chapter NR 140 groundwater quality standards for the most frequently occurring dissolved phase inorganic COPCs based on historic groundwater monitoring results. However, iron and manganese were detected in samples collected from up gradient wells[4] at concentrations above groundwater quality standards. Because these elevated concentrations represent background conditions, the maximum detected concentrations have been substituted as the acceptable contaminant level for COPCs that exceed groundwater quality standards in background samples. A summary of the acceptable contaminant levels for inorganic COPCs in the Miller Creek and Copper Falls aquifer follows: The concentrations provided in the table below provide a conservative level that will be further refined in subsequent technical memoranda and the FS.

Preliminary Remediation Goals (µg/l) for Inorganic COPCs in Groundwater			
Inorganics	**ES**	**Background Concentrations for Miller Creek (Well MW-11)**	**Background Concentrations for Copper Falls (Well MW-6A)**
Arsenic	6	0 – 3.2	0 – 4.4
Antimony	10	0 – 4.3	0 – 4.1
Barium	2,000	130 – 260	640 – 710
Beryllium	4	ND	ND
Cadmium	5	0 – 0.2	ND
Chromium (+3) Chromium (+6)	100*	ND	0.87 – 2.1
Cobalt	40	0 – 16	0 – 1.1
Copper	1,300	2 – 35	2.4 – 6.1
Cyanide	200	0 – 17	0 – 4
Iron	300	7.1 – 19,000	0 – 0.0046
Lead	15	0 – 3.3	0.485 – 2.6
Manganese	50	13 – 760	30 – 410
Mercury	2	ND	ND
Nickel	100	0.95 – 24	1.6 – 4.7
Selenium	50	0 – 3.3	0 – 2.8
Silver	50	0 – 1.65	0 – 0.8
Thallium	2	ND	ND
Vanadium	30	2.1 – 38	9 – 10
Zinc	5,000	0 - 59	0 – 17

* Chromium in groundwater will be presented as total chromium per the WI ch. NR 140 standard

Free phase hydrocarbons (tar) encountered in the Kreher Park fill, ravine fill, NSPW property and Copper Falls aquifer are behaving as a source for the dissolved phase plumes identified in each unit at the Site. PRGs for free-phase tar are within these units are based on WAC NR 708.13, which states the following:

[4] Samples collected from well MW-11 located outside the ravine fill represents background conditions for shallow groundwater in the upper bluff area, and samples collected from MW-6A represent background conditions for the underlying Copper Falls aquifer.

> Responsible parties shall conduct free product removal whenever it is necessary to halt or contain the discharge of a hazardous substance or to minimize the harmful effects of the discharge to the air, lands or waters of the state. When required, free product removal shall be conducted, to the maximum extent practicable, in compliance with all of the following requirements:
>
> **(1)** Free product removal shall be conducted in a manner that minimizes the spread of contamination into previously uncontaminated zones using recovery and disposal techniques appropriate to the hydrologic conditions at the site or facility, and that properly reuses or treats discharges of recovery byproducts in compliance with applicable state and federal laws.
>
> **(2)** Free product removal systems shall be designed to abate free product migration.
>
> **(3)** Any flammable products shall be handled in a safe and competent manner to prevent fires or explosions.

Using the above criteria, the removal of free-product (tar) will be further refined in subsequent technical memoranda and the FS.

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